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Shall Men Be Laid Off?
Shall Our Soldiers Die?

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Dig it out. It's *urgently* needed—to keep war production flowing—to keep men at work—to protect our soldiers against the enemy.

Put a competent man or a committee to work on a special campaign of your own. Tell *every* man in your plant how important scrap is today. Post this story on your bulletin board, (we'll gladly send reprints). Pile up every piece—no matter how small. You'll be surprised at the amount you find. Then call your nearest junk or scrap dealer. He'll buy it from you—and send it on its way to a steel mill.

If you and every plant does this *PROMPTLY*, you'll be helping to hasten the end of the war—you'll be helping to save the lives of those who fight for you.

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In Cooperation with the U. S. Government's Salvage Campaign

☆ PROTECTING WIRE ROPE AGAINST CORROSION ☆

This is Number 11 in a series of informative articles prepared by Macwhyte Wire Rope Company. The purpose of this series is to help wire rope users in these critical times to get the longest possible service from present ropes . . . through making useful facts on rope care more widely known.

The preceding article, No. 10 in this series, pointed out the causes of wire rope corrosion, where and when it was likely to strike. This article, No. 11, tells how to guard against corrosion. This and the previous ten articles in the series is available on request on your company letterhead.

Lubrication . . . its importance

No way has yet been found to remove the "causes" of corrosion. However, there is a method of protecting wire rope against corrosive elements . . . against atmosphere, weathering, or special conditions which subject the rope to either acid or alkaline substances.

That method is . . . *thorough lubrication.*

A recent and good illustration of such protective practice is found in the automotive industry. When car makers turned their plants into war production centers they ripped out massive automobile dies and machines worth millions, carted them to parking lots for the duration. When peace comes, back to work they will go.

Meanwhile these machines and dies are being protected against corrosion by a *thick coating of grease.*

Wire ropes, too, are machines. When in use (and more so when inactive) their parts need the protection good lubrication gives. Only when protected by lubrication (which retards corrosion) will they give the best possible service. Today, when we must all conserve what we have, such protection is doubly important.

Corrosion starts as soon as wires and strands are exposed to the elements and usually starts before one is aware of it.

In its early stages, corrosion is difficult to detect. The first signs are general discoloration of the wires of the rope. As corrosion progresses, the wires will become either pitted or covered with a reddish brown substance depending upon whether the corrosion is of an acid or alkaline type.

To prevent such destruction... LUBRICATE

Destruction came to these wire ropes much too soon. It might have been prevented. At an early inspection periodic lubrication would have added countless hours to the service life of these ropes.

Ⓐ *This sample,* in addition to showing evidence of wear, is very badly corroded due to having been subjected to corroding conditions of an alkaline nature.

Ⓑ *Lack of lubrication* caused the wires in this rope to become rust-bound. Fractures of this character occur when suddenly picking up the load or when the rope is flexed over the sheave, because the rust-bound wires cannot properly slide by each other. Notice the wires show very little evidence of wear.

NO. 692

Curb Corrosion and Conserve Steel

Corrosion is like an incurable disease which creeps up on a person gradually. You may check the damage it is doing, but you can never repair the damage done. Eventually it leads to early death of a rope whose service life could have been so much longer . . . with ordinary care.

Today corrosion is a very real enemy, destroying vital material (steel) needed for victory. If you inspect your ropes regularly, and apply lubricants freely, frequently, you are doing your bit to defeat this wire rope saboteur and get maximum service from your wire rope.

If you have further questions on corrosion (or any wire rope problems) feel free to write us about them. Simply address Macwhyte Company, 2940 Fourteenth Avenue, Kenosha, Wisconsin. Please write on your company letterhead.

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August, 1942

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C O N T E N T S

DRILLING AND PRODUCTION *Page*

Cements for Oil and Gas Wells (Part 1) ... 23
By LESTER C. UREN

Progress in Reservoir Technology (Part 1) ... 27
By MORRIS MUSKAT

Use of Explosive Cord for Cleaning Perforations ... 42
By WALLACE A. SAWDON

Repairing and Redrilling Oil Wells ... 46
By J. R. THOMAS

Durability of Cements in Contact with Brines and Chemical Solutions ... 50
By H. H. MILLER

Oil-Well Cementing ... 82
By J. V. POLK

REFINING AND NATURAL GASOLINE MANUFACTURE

Refinery Practice for the Operating Man (Vocational Class Proceedings in Refinery Engineering) ... 36

Design and Operation of Cycling Plant Absorption Systems ... 56
By ELMER T. NEILL

Natural Gas Cycling Course ... 88
By FRANK H. DOTTERWEICH

OIL AND GAS TRANSPORTATION

Pipe Line Laid Through Rough Terrain of West Virginia ... 75
By FRANK H. LOVE

Compressor Station Equipped with Radiator Cooling System ... 79
By C. L. MOORE

Effect of Friction in Air Inlet and Exhaust Systems of Internal-Combustion Engines (Part 2. Concluded) ... 92
By ORVILLE ADAMS

GENERAL

Ameripol—Synthetic Rubber Developed by U. S. Scientists ... 31
By C. C. PRYOR

Avoiding Static in Belts ... 40

The U. S. Patent System ... 69
By GEORGE T. GILL

Installing Boiler Blow-down Receiver and Piping ... 76
By J. C. ALBRIGHT

Determining the Area of a Cylindrical Surface ... 86
By W. F. SCHAPHORST

Procedure for Obtaining Higher Priority Rating ... 133

Functions of Foreign Division OPC Defined ... 133

Some Petroleum Industry Jobs Listed as Essential ... 133

Procedure for M-68 Exceptions ... 133

ENGINEERING NEWS OF INTEREST

Photomicroscopy of Salt in Petroleum ... 48

REGULAR FEATURES

The Course of Oil ... 10
Highlights in Oildom ... 12
Major Pipe Line Activities ... 14
Major Oil Field Activities ... 16
Petroleum Statistics and Field Operations ... 18
Major Refining Activities ... 20
The Petroleum Engineer's Continuous Tables (Installment No. 62) ... 101
Running Tour With Men in the Industry ... 117 and 118
Laugh With Barney ... 120
Machinery and Equipment ... 122, 123, 124, 125, and 126
From Washington ... 133
Trade Literature ... 144 and 145
Book Reviews ... 146
Meetings ... 147

MEMBER A. B. C.—A. B. P. (The articles in *The Petroleum Engineer* are indexed in the *Industrial Arts Index*, New York, N. Y.

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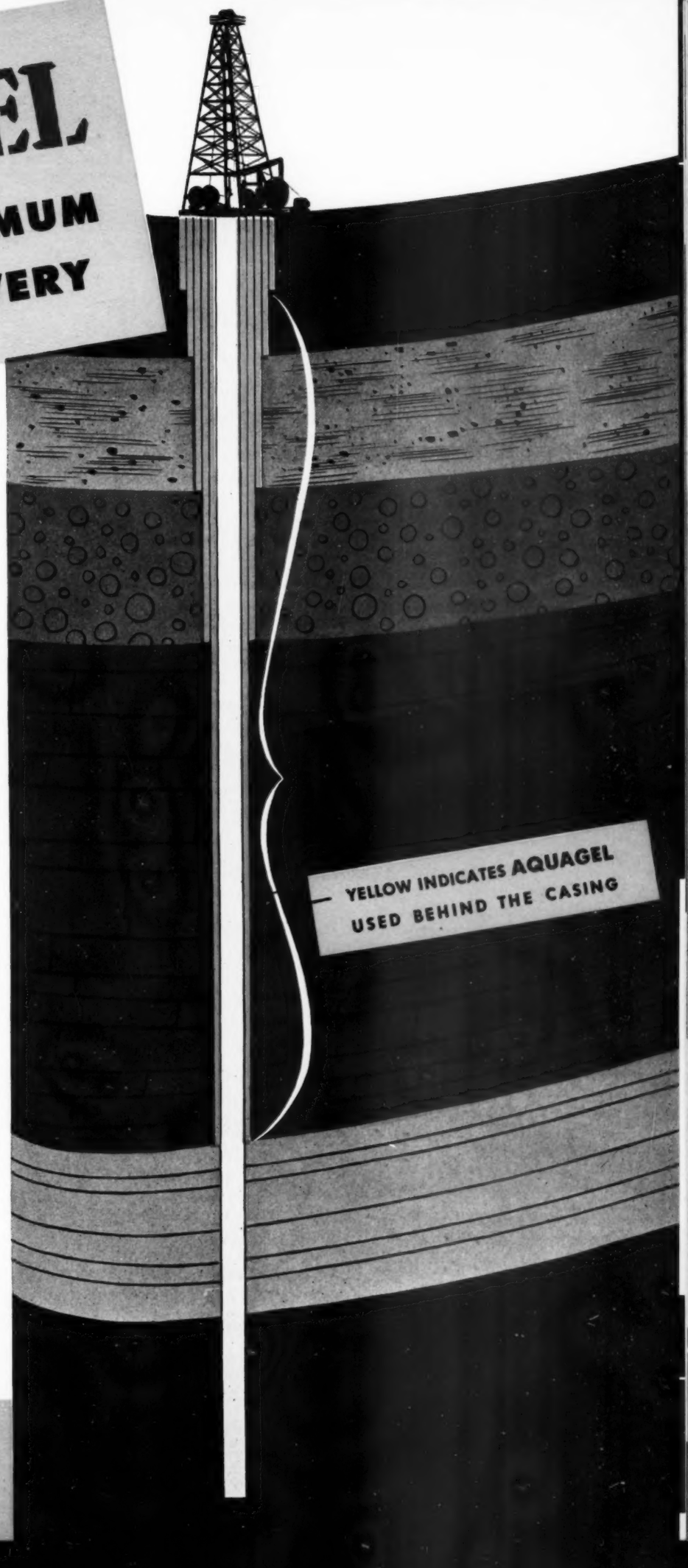

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The Course of Oil

by K. C. SCLATER

Oil or National Revenue?

Were it not for the depletion allowance, many oil properties of settled production, the wells of which are the backbone of the nation's current oil supply, could not be operated and so bring about a drastic reduction in oil production. Apparently the Secretary of the Treasury does not recognize this fact. He doggedly persists in advocating a reduction or removal of the depletion allowance. His utter disregard of the consequences on the nation's oil supply of removing the depletion allowance is difficult to understand. It is a matter about which the petroleum industry cannot afford to be complacent.

In a statement before the Senate Finance Committee last month, decrying the depletion allowance, he said that "special privileges are intolerable at a time like this, when we are imposing heavy taxes on persons with small incomes and there is pressure for limiting wages and farm prices. The country is in greater danger today than ever before in its history. The war is now in its most critical phase, and only by pulling together as a united people can we make the effort that will turn the tide toward victory. At such a time any special privilege for any group not only deprives the Treasury of revenue that is badly needed for the war effort, but it hinders the war effort by undermining the morale without which the war cannot be won."

While recognizing that the country is in greater danger today than ever before and that the war is now in its most critical phase, Secretary Morgenthau's ironical statement overlooks the grave consequences that must inevitably result from cutting off the depletion allowance. He fails to recognize the danger a shortage of petroleum would create. He ignores the fact that the discovery of new oil reserves is lagging and that the United States might within the new few months be the only main source of oil supply left to the Allied nations. The course of the war in Russia during the last few weeks makes it imperative that oil exploration be conducted on a much greater scale than at present if the United States must supply the total petroleum needs of the Allied nations for the duration—as it may shortly be called upon to do. Secretary Morgenthau contends that the Treasury loses between eighty and two hundred million dollars annually because of the depletion allowance, but Russell B. Brown of the I. P. A. points out that "Since estimating income comes peculiarly within his (Secretary Morgenthau's) duties, let's accept for the purpose of this statement the top of his very uncertain figure of 200 million. That would pay our part of war participation for a period of nearly two days. Suppose he is wrong. Suppose that the experts in the Coördinator's office are right. Suppose the National Conference of Petroleum Regulatory Bodies is right. Suppose the Petroleum Industry War Council is right. Suppose the oil industry is right—that the taking away of the depletion allowance would slow down our oil discovery operations. Suppose our increased demand for oil could not be met promptly. It could easily cause the delay in the successful conclusion of this war for more than two days with its consequent cost in money and life—or what is more, we stand to *lose the war.*"

Intelligent State Cooperation

One oil field in the nation, the Smackover field, Arkansas, has recently been given a blanket M-68 Exception Order. Application for the exception for the entire field was initiated by the state and is one of the first instances in which a state agency has applied for relief from a Federal restriction in a stripper pool. Not only did the state agency—in this instance, the Arkansas Oil and Gas Commission—prepare the application for exception in behalf of all operators in the field, but it also assembled the evidence and data supporting the application. Operators were thus spared the delay and expense and also the loss of production that would have ensued had individual application been made for each well.

More than thirty-seven hundred wells have been completed in the field and there are still sixteen hundred nineteen wells producing, all by pumping.

The exception was granted in order to allow operators to plug back wells to shallow producing horizons. Many wells in the field produce water in such quantity from lower zones that it will soon be necessary to salvage as much of their equipment as possible and abandon them, unless they can be recompleted in one of the upper producing zones. These upper zones also make some water, but not in quantities that excessively burden pumping equipment. By recompleting wells in the shallower zones it has been found that their productive life has been substantially prolonged and the ultimate oil recovery increased. Plugging-back in this field is therefore a profitable operation that leads to greater producing efficiency, imposing less strain on critical equipment and reducing pumping expense, all very important considerations in these times. Other than cement and the steel bullets used in perforating, there is no great expenditure of materials required in these plugging-back operations.

The Oil and Gas Commission of Arkansas in initiating this program and supplying the essential data accompanying the application, has done a great service to the operators in enlarging their contribution to the war effort. The efficient and time-saving procedure followed in applying for a field-wide exception in the Smackover field might very well be adopted in other oilfields where the conditions are favorable.

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Highlights IN OILDOM

Field Rules for Quinto Creek Field

The Texas Railroad Commission has announced rules for the Quinto Creek field, Jim Wells County, Texas.

The rules provide for development on 40-acre units, for spacing of 933 ft. between wells, with wells to be at least 467 ft. from property lines.

A general gas-oil ratio of 2000 cu. ft. per bbl. has been established, except that wells having a higher ratio will be permitted to produce daily that volume of gas obtained by multiplying its daily allowable by 2000 ft. Gas wells producing from the same reservoir are allowed a monthly maximum equal to the average monthly oil allowable multiplied by 2500.

Sour Gas Damages Arkansas Wells

The Arkansas Oil and Gas Commission announces that sulphuric acid, formed by hydrogen in the gas, has corroded and eaten away casing in about 40 wells in the Magnolia field, Columbia County, in several cases causing near blowouts. The field, which has an estimated reserve of approximately 160,000,000 bbl. of crude oil underlying 200,000,000,000 cu. ft. of gas containing hydrogen sulphide, "would be in danger of ruin if any one of the 115 wells should get out of control," a statement by the Commission said.

Grady H. Vaughn of Dallas, Texas, a large operator in the field, has offered the first practicable means of coping with the danger presented by sour gas corrosion. His method, used on his own wells, has been to fill the annular space between tubing and casing with mud weighing about 10 lb. per gal.

Most of the field's 115 producers were completed by setting a string of 10-in. casing at a depth of 2000 ft., then drilling to 7500 ft. and setting 7-in. casing. Vaughn sets a packer on the tubing at approximately 7000 ft. and fills the annular space between tubing and casing from that depth to the surface.

Quarterly Report on East Texas Wells

The Engineering Department of the Texas Railroad Commission has issued its quarterly report on the East Texas field.

The report, which is for a total of 9189 wells, is as follows:

Flowing wells making water, 961; pumping wells making water, 4010; pumping wells not making water, 3220; total, 7230.

Air- and gas-lift wells making water, 559; air- and gas-lift wells not making water, 439; total, 998.

Marginal wells making water, 1006; proratable wells making water, 4524; total, 5530.

Daily water withdrawals from all wells making water, 435,549 bbl.; from marginal wells making water, 232,312; from proratable wells making water, 203,237.

Average daily withdrawals per marginal well, 230.93; average withdrawal per proratable well, 44.92, and average withdrawal per water well, 78.76.

Census Survey of Oil and Gas Production Issued

Approximately 200,000 persons worked in petroleum and natural gas production activities in 1939, the U. S. Bureau of the Census reports. Its report, the first comprehensive census survey of the industry since 1919, reveals that 7782 companies were engaged in the production of oil and gas, and that at the end of 1939 they operated 300,179 oil and gas wells, and 47,466 gas wells.

The Census Bureau figures do not agree strictly with those published by the U. S. Bureau of Mines. For example, the oil producers covered by the census produced 1,228,134,000 bbl. of crude oil in 1939, compared with Bureau of Mines production of 1,264,962,000 bbl. The census reports 300,179 oil wells, whereas the Bureau of Mines shows 380,390 operating at the end of 1939. The census report, however, gives operating facts in much greater detail, and reveals the distribution of operating expenses and many other figures not published in Bureau of Mines reports.

Total value of products of the industry, $1,472,291,339, exceeded that of any other mineral industry, and accounted for 43 percent of the total for all mineral industries.

Principal expenses included $199,732,062 paid to contractors for drilling wells (about 60 percent of the 22,560 wells drilled in 1939 were completed by contractors), $168,382,732 paid direct for labor to an average 113,498 wage earners, $83,844,270 in salaries to 32,327 salaried employees, $86,690,393 for supplies and materials, $26,059,971 for fuel, and $7,093,569 for purchased electric energy. The latter items do not, of course, include sums expended for similar purposes by drilling contractors and covered in their expenses.

Total drilling costs for the 22,560 wells amounted to $404,904,000 or an average of about $18,000 a well. Dry holes, which failed to find oil, totaled 3703, indicating that $70,000,000 was spent by the petroleum industry with no return.

The complete census report gives a breakdown of all principal facts of drilling and operating oil and gas wells, including all figures for the principal producing states. Included are data on footage drilled, costs, man-hours of labor, contracted drilling, well servicing and maintaining, etc. Copies of the report, "Mineral Industries, 1939: Crude Petroleum and Natural Gas," may be obtained from the U. S. Bureau of the Census.

Extraction of Magnesium from Oil-Field Brines Considered Possible

Salt water, bane of the oil producer since the birth of the petroleum industry, may now be made to "pay off." Preliminary investigations made in the Oklahoma Geological Survey laboratory, at Norman, indicate the possibility of extracting magnesium from oil-field brines, as a by-product of disposing of the waste fluid that must be pumped from many wells in order to produce oil.

The process suggested by A. L. Burwell, chemical engineer on the Survey staff, is similar to that now in use at Freeport, Texas, on seawater and calls for the controlled treatment of the brine with milk of lime or milk of dolomite.

Analyses of many brines from Oklahoma oil fields indicate the presence of considerable proportions of magnesium. At the present time, salt water is a nuisance and a hazard to the oil industry, and the annual toll on the industry's profits to dispose of these brines in order to prevent pollution of streams, and damage to land, is very great. The most satisfactory, and at the same time, the most expensive system for handling oil-field brine, is disposal into subsurface formations, through input wells. Rather elaborate disposal systems, with an aggregate capital investment of several million dollars, have been built in Oklahoma, particularly in the newer fields, during the last few years.

It is Burwell's opinion that the procedure at these disposal plants could be modified slightly, whereby the magnesium salts may be removed before the brine is returned to the subsurface formation. Thus an operation of the oil industry that is now a total loss, and source of continuous expense, may be turned into a profit.

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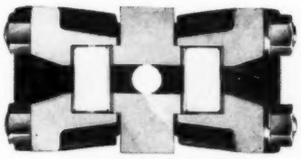

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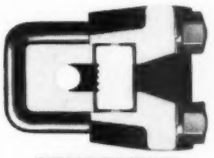

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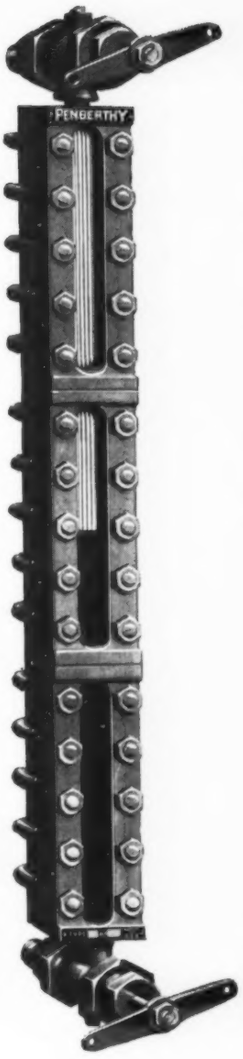

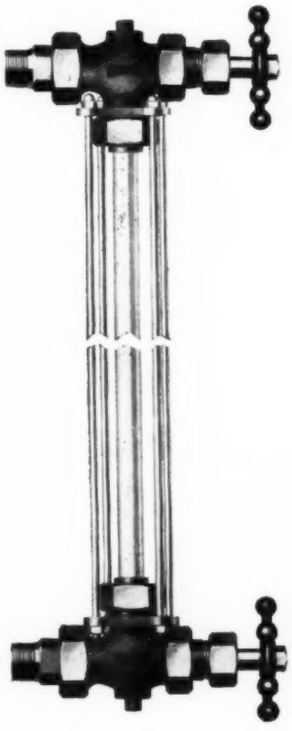

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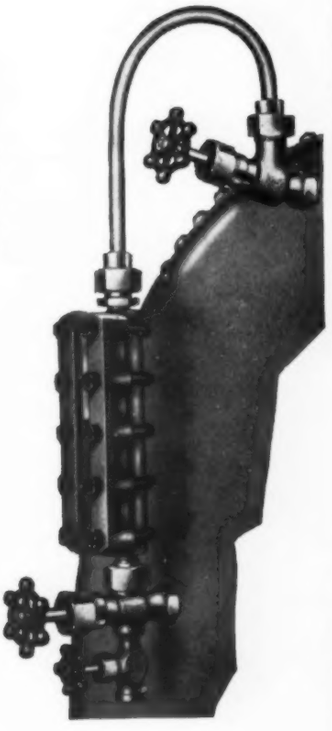

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MAJOR *Pipe Line* ACTIVITIES

PETROLEUM Coördinator for War Harold L. Ickes has announced the awarding of contracts for construction of the world's largest oil-carrying pipe line—the 24-in., 550-mile emergency line from Texas to Illinois, which will help supply the essential oil requirements of the eastern seaboard next winter.

With clearance of right-of-way proceeding on schedule and pipe already being strung out in the field, welding and ditching operators are scheduled to begin work immediately, the Coördinator said. When completed in December, the line will deliver 300,000 bbl. of East Texas crude oil each day in Illinois for transshipment eastward by railroad tank car, river barge, and pipe line.

Seven different pipe-line contractors have been assigned the job of laying the main line between Longview, Texas, and Norris City, Illinois, and two smaller branch lines from Norris City to river barge and pipe-line terminals at Mt. Vernon, Indiana, and Enfield, Illinois, respectively.

Contracts were awarded on a cost plus fixed fee basis, according to information supplied the Coördinator's Office by B. E. Hull, vice-president and general manager of War Emergency Pipeline, Inc., the company organized by the oil industry to plan and supervise the building of the line for the Federal Government. Hull said the fixed fees agreed upon vary as between contractors but average about $1000 per mile of pipe to be laid. Total cost of the line, which is being financed by the Government through the Defense Plant Corporation, is estimated at $35,000,000.

Hull reported that through Friday (July 31) a total of 692 carloads of pipe had been dispatched from the Lorain, Ohio, mill of the National Tube Company, and that 425 of these had been received and unloaded.

Ditching operations are conducted simultaneously with stringing, so that as fast as the lengths of pipe are welded into solid strings they can be placed in the earth and covered.

Each contractor will lay a single section of the line, as follows:

1. Section from Longview, Texas, to Arkansas-Texas state line awarded to Williams Brothers, Tulsa, Oklahoma.

2. Section from Arkansas-Texas state line to Gurdon, Arkansas, awarded to O. E. Dempsey Construction Company, Tulsa, Oklahoma.

3. Section from Gurdon, Arkansas, to Little Rock, Arkansas (Arkansas River), awarded to Anderson Brothers, Tulsa, Oklahoma.

4. Section from Little Rock to Missouri-Arkansas state line (St. Francis River), awarded to Oklahoma Contracting Company, Dallas, Texas.

5. Section from St. Francis River to Illmo, Missouri (Mississippi River), awarded to C. S. Foreman Company, Kansas City, Missouri.

6. Section from Mississippi River to Harrisburg, Illinois, awarded to Ray E. Smith Construction Company, Eldorado, Kansas.

7. Section from Harrisburg, Illinois, to Norris City, Illinois, awarded to Sheehan Pipe Line Construction Company, Tulsa, Oklahoma.

Sheehan Pipe Line Construction Company also was awarded the contract for construction of the 14-in. branch line from Norris City to Mt. Vernon, Indiana, and for the 10-in. branch line from Norris City to Enfield, Illinois.

Contracts for the construction of eight river crossings were awarded to Williams Brothers. The line will cross the Red, Little Missouri, Ouachita, Arkansas, Cache, White, St. Francis, and Mississippi Rivers, the latter at a point just below Cape Girardeau.

Reporting in detail on the progress that is being made, Hull said that one clearing gang is working southward from the Arkansas state line clearing right-of-way in Cass County, Texas, while another is working northward clearing right-of-way in Miller County, Arkansas.

All along the route of the "big inch" line, the various contracting companies were getting ready for an all-out construction effort.

Williams Brothers construction equipment is assembled at Ravana, Arkansas, to move southward. Dempsey Construction Company equipment is assembled at Ravana, to move northward. About 40 cars of pipe was the initial shipment to Ravana, Mildar, and Fort Lynn.

Oklahoma Contracting Company construction equipment is assembled and limbered, to start northward from Arkansas River, North Little Rock; other gang to start southward from Missouri state line.

Anderson Brothers equipment is assembled and to begin work from Arkansas River southward.

Sheehan Pipe Line Construction Company and Ray L. Smith Construction Company each have equipment on ground at starting point 8 miles west of Harrisburg, Saline County, Illinois. Pipe for these two gangs began arriving August 5. Sheehan will work northward toward Norris City, Illinois, and Mt. Vernon, Indiana, to which a branch of the line will be run from Norris City. Smith will work southward toward Mississippi River.

First pipe has been shipped to Cape Girardeau for the section from the Mississippi River to the Arkansas state line.

Foreman Construction Company assembled their machinery at Cape Girardeau.

The War Emergency Pipelines' personnel at Little Rock, Arkansas, where offices have been established in the Rector Building, includes:

B. E. Hull, vice-president and general manager, president of The Texas Pipe Line Company.

Maj. A. N. Horne, general superintendent, formerly manager of Empire Pipe Line Company, Bartlesville, Oklahoma.

Brady Cole, Houston, Texas, a member of the law firm of Baker, Botts, Andrews and Wharton, is serving as associate general counsel.

J. W. Cason, Shreveport, Louisiana, formerly with Standard Oil Company of Louisiana, is serving as treasurer and comptroller.

Harry J. Lingle, Houston, Texas, Humble Pipe Line Company, is serving as purchasing agent.

Oscar Wolfe, Houston, Texas, The Texas Company, is chief engineer of lines.

L. M. Goldsmith, Philadelphia, Pennsylvania, Atlantic Refining Company, is chief engineer of pump stations and terminals.

R. E. Harrell, formerly right-of-way and claims agent for Plantation Pipe Line Company, is chief of the same phase of operations for War Emergency Pipelines.

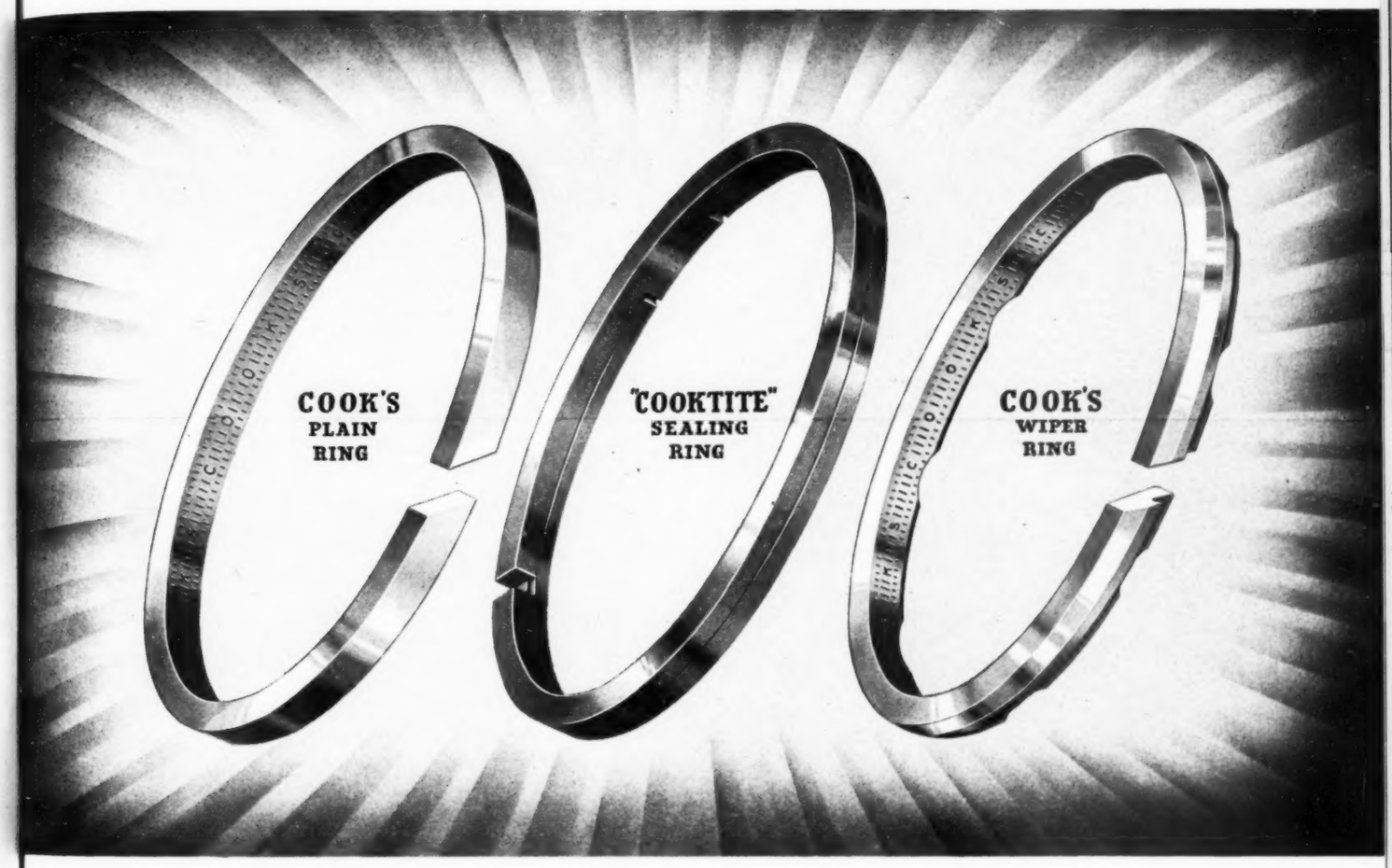
Kenneth A. Owen, Houston, Texas, formerly with The Texas Pipe Line Company, is assistant to Hull.

E. Carey Lind, formerly in the freight traffic department of Missouri Pacific Railroad at Little Rock, is freight traffic manager.

O. R. Burden, Wichita Falls, Texas, is division superintendent.

Charles P. Cathers, Washington, D. C., supervising engineer for Defense Plant Corporation.

THE SPIRIT OF '42



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COOK'S *GRAPHITIC IRON* PISTON RINGS

MAJOR *Oil Field* ACTIVITIES

FOUR separate zones of the Viola lime were reported as showing oil in the well, Bredthauer et al., Fee No. 1, CSW NE of 28-17-12w, north of the Loup River on the northeast flank of the Cambridge arch in Greeley County, Nebraska. The zones reported showing oil were at 3028 to 3033 ft.; 3034 to 3048 ft.; 3118 to 3123 ft., and 3191 to 3201 ft. A strong odor of gas was noted at 3224 ft. in the St. Peter sandstone. At last reports operators were to run and set casing for tests.

Jack Hildreth No. 1, a Viola lime wildcat in Montague County, 8 miles north of Bowie, Texas, drilled by the Continental Oil Company, drilled plug and was testing saturation at 5546 to 5703 ft. The well produced 57 bbl. of oil in four hours, then was shut in. Opened later, the well flowed 35 bbl. in a 35-minute period, but died down. Operators are preparing to resume swabbing through 2-in. tubing.

Four and one-half miles southwest of Nocona, Texas, Sinclair Prairie Oil Company's No. 1 Forshee, block 135, J. H. Belcher subdivision, penetrated the conglomerate at 5998 ft. and drilled to 6008 ft. with good saturation. A 30-minute drill-stem test from 6001 to 6008 ft. recovered 1080 ft. of oil and 40 ft. of oil-cut mud. An electrical log was run and casing will be set for a test.

Jefferson Davis Parish, Louisiana, has a new oil field opened by H. M. Naylor's Acadia Development Company No. 2. Ten bbl. of oil per hour were gauged through an 1/8-in. choke from the Marginulina section of the Oligocene at a total depth of 10,581 ft. Production was from the sand section from 10,175 to 10,206 ft. The casing was perforated from 10,198 ft. to 10,206 ft. On the drill-stem test the well showed 1250 ft. of 45.7-gravity oil in 15 minutes with the pressure 2850 lb. Flowing pressure through the choke was 4100 lb. with a closed-in pressure of 5600 lb. Gas-oil ratio was 1200 to 1.

Harrison and Abercrombie indicated in a permit form on file with the Texas Railroad Commission that they would drill the deepest oil well ever drilled in Texas in the Old Ocean field, Brazos County. Staked as McDonald No. 1-B, the well will be 660 ft. out of the west corner of a 333.457-acre tract in the Battle-Berry and Williams survey.

Humble Oil and Refining Company has continued work on a wildcat test on the Larissa structure in northwestern Cherokee County, Texas, now below 10,100 ft. The well, H. F. Curtis No. 1, John Vaughn survey No. 53 is thought to have found a new deep petroleum reserve for East Texas. A soft spot was found in the basal Rodessa or the Pettit zone at 10,165 ft. and was cored to 10,195 ft., finding nearly 30 ft. of porous Oölitic lime. It is believed that the zone will produce gas-condensate. A test in the upper Rodessa section at 9780 to 9880 ft. had shown for a small amount of gas-condensate.

The Pure Oil Company has opened a new field in Carter County, southern Oklahoma, with Fraser No. 1, SW NW SE of 26-3s-1, about two miles north of previous production. Total depth of the well is 5348 ft. The well flowed an average of 100 bbl. of oil and 35 bbl. of water per hour through 2-in. tubing on an 8-hour test. The corrected gravity of the oil was 38.0. Testing and cleaning of the well is continuing, as the water is believed to be from the drilling fluid.

AVERAGE CRUDE OIL PRICES

California	
Kettleman Hills	$1.23-1.29
Playa Del Rey	.80- .87
Coalinga	.73-1.13
Wilmington	.68-1.24
Montana	1.00-1.15
Wyoming	.45-1.15
Colorado	1.05-1.07
New Mexico	.70-1.15
Texas	
North Central	.97-1.21
Panhandle	.70-1.12
West Texas	.80-1.27
Gulf Coast	.93-1.48
Darst Creek	1.14
East Texas	.80-1.27
Talco	.79
Kansas	.93-1.25
Oklahoma	.75-1.25
Arkansas	.94-1.36
Louisiana	
Rodessa	$ .88-1.20
Gulf Coast	.93-1.36
North Louisiana	.98-1.30
Illinois	1.22-1.37
Kentucky	1.32-1.43
Indiana	.85-1.25
Ohio	
Lima	1.17
Michigan	1.24-1.44
Pennsylvania	
Bradford	3.00
Southwest	2.65
Eureka	2.59
Buckeye	2.55
Corning	1.31

DAILY AVERAGE CRUDE OIL PRODUCTION

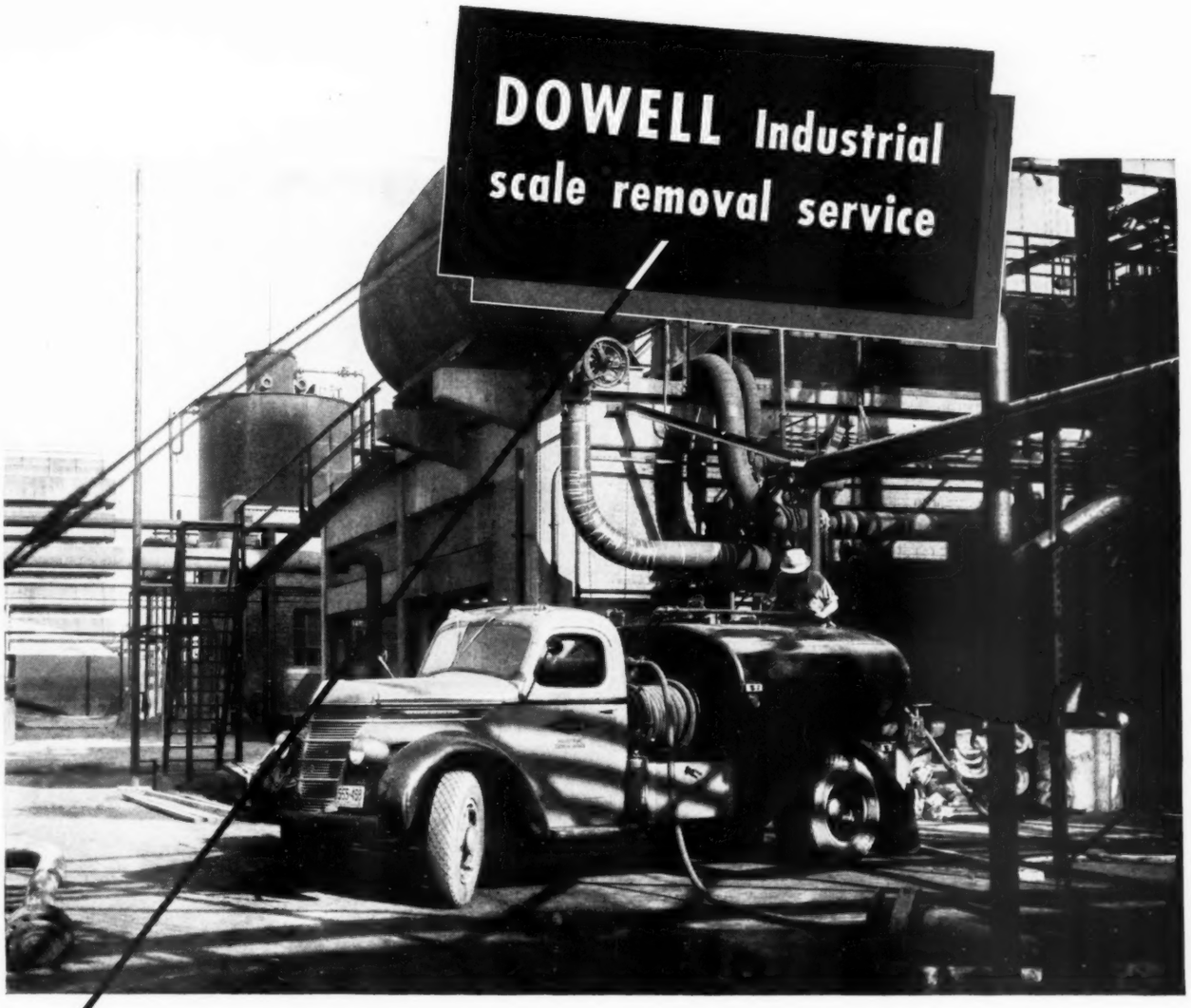
Data Supplied by A.P.I.

(Figures in bbl. of 42 gal. each)

	[1]O.P.C. Recommendations July	Week Ended Aug. 1, 1942	Week Ended July 27, 1942	Week Ended Aug. 2, 1941
Oklahoma	433,000	[2]383,400	369,300	417,050
Kansas	283,200	[2]280,050	272,100	235,500
Nebraska	4,100	[2] 3,500	3,750	5,050
Panhandle Texas		65,800	107,000	80,750
North Texas		139,100	149,400	129,550
West Texas		138,200	234,450	221,650
East Central Texas		74,850	94,050	79,400
East Texas		218,050	295,000	298,550
Southwest Texas		99,100	163,600	180,250
Coastal Texas		171,450	280,800	242,350
TOTAL TEXAS	1,214,400	906,550	1,324,300	1,232,500
North Louisiana		96,200	90,700	78,550
Coastal Louisiana		234,600	220,000	240,350
TOTAL LA.	319,600	330,800	310,700	318,900
Arkansas	78,500	72,500	73,700	73,300
Mississippi	49,900	[2] 82,000	83,500	47,750
Illinois	304,100	274,350	274,500	357,650
Indiana	22,000	[2] 18,300	18,650	20,350
Eastern (Not incl. Ill. & Ind)	112,600	102,550	98,450	94,800
Michigan	64,800	62,500	65,700	42,450
Wyoming	96,800	90,750	92,150	82,600
Montana	23,100	21,650	22,350	20,400
Colorado	7,700	6,800	7,450	4,000
New Mexico	89,500	70,650	65,150	109,750
TOTAL EAST OF CALIF.	3,103,300	2,706,350	3,082,150	3,062,050
California	739,500	676,700	637,300	633,200
TOTAL U. S.	3,842,800	3,383,050	3,719,450	3,695,250

[1]O.P.C. recommendations and state allowables represent the production of all petroleum liquids, including crude oil, condensate and natural gas derivatives recovered from oil, condensate and gas fields. Past records of production indicate, however, that certain wells may be incapable of producing the allowables granted, or may be limited by pipeline proration. Actual state production would, under such conditions, prove to be less than the allowables. The Bureau of Mines reported the daily average production of natural gasoline in April, 1942, as follows: Oklahoma, 27,500; Kansas, 4,800; Texas, 90,700; Louisiana, 15,300; Arkansas, 2,600; New Mexico, 5,300; California, 40,100; other states 22,200.

[2]Oklahoma, Kansas, Nebraska, Mississippi, Indiana figures are for week ended 7 a. m., July 29.



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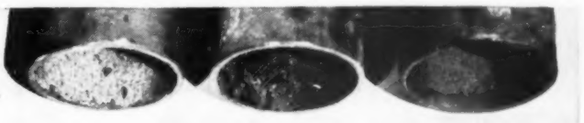

Three sections of the same boiler tube; No. 1, before cleaning; No. 2, after mechanical cleaning; No. 3, after being cleaned the Dowell way.

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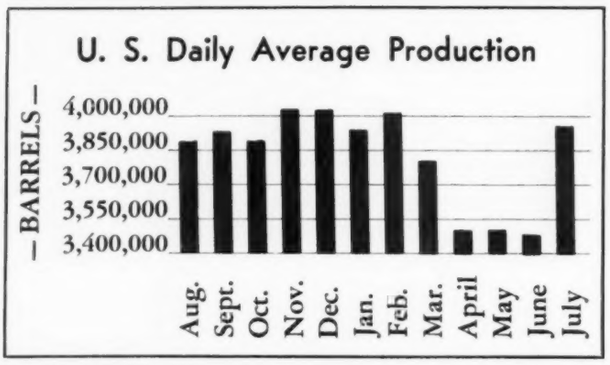
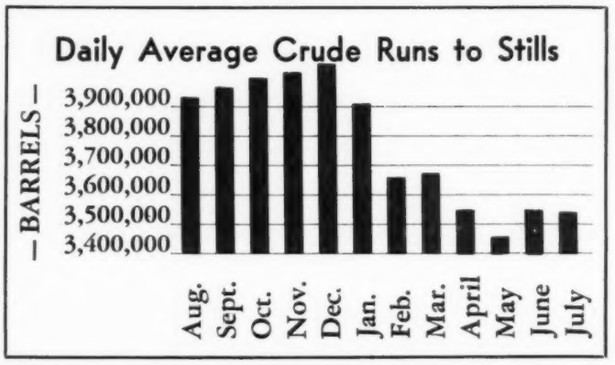
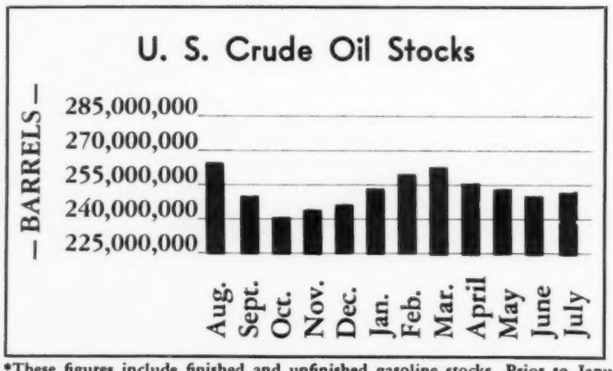
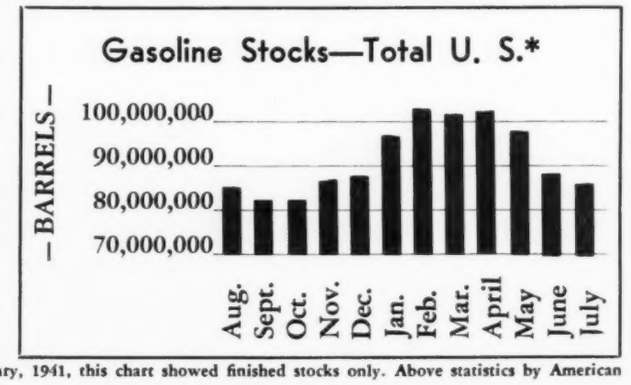
PETROLEUM *Statistics* AND FIELD *Operations*









*These figures include finished and unfinished gasoline stocks. Prior to January, 1941, this chart showed finished stocks only. Above statistics by American Petroleum Institute.

Summarized Operations in Active Fields for July, 1942

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strongs	Gravity of Oil	Type of Tool Used
TEXAS								
East Texas	24	20	5	....	3500-3700	2	40	Rotary
Gaines County	5	3	3	....	4400-5584	2	22-35	Rotary
Hockley County	20	16	2	....	4800-6850	2	20-30	Rotary
Ector County	11	9	4	....	3675-4377	2 or 3	32-36	Rotary
Panhandle	33	28	5	....	1700-3900	2	40	Rot.-Cab.
Nueces County	7	7	6	....	3922-5878	2 or 3	21-54	Rotary
K. M. A. Field	13	8	3	....	3730-3935	2	42-43	Rot.-Cab.
Hawkins Field	21	19	4	....	4495-4912	2	19-29	Rotary
OKLAHOMA								
Okfuskee County	7	5	6	3	2150-4125	2 or 3	38	Rotary
KANSAS								
Russell County	14	8	4	....	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	15	7	7	....	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	13	10	7	....	3290-3518	2	39-42	Rot.-Cab.
ILLINOIS								
Central Illinois	169	161	82	107	1425-4100	2	36-38	Rot.-Cab.
NEW MEXICO								
Lea County	12	9	4	5	3150-4030	2	30-34	Rot.-Cab.
CALIFORNIA								
Kern County	13	6	7	7	1840-11,450	3 or 4	14-30	Rotary
Wilmington	7	4	2	3	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for July, 1942

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1941 (In Barrels)
	July	June	July	June	July	June	July	June	July	June	
Arkansas	14	12	12	11	9	6	8	10	18	15	29,263,000
California	52	48	47	44	25	28	40	45	33	31	230,271,000
Colorado	....	....	....	....	....	....	....	....	....	....	1,792,000
Illinois	169	163	161	158	63	65	82	80	107	92	131,272,000
Indiana	43	47	37	41	18	17	8	10	20	18	6,998,000
Kansas	142	146	140	127	77	87	14	15	36	32	82,733,000
Kentucky	8	13	4	6	6	4	....	....	....	....	4,790,000
Louisiana	171	152	127	118	66	61	18	14	18	11	116,038,000
Michigan	42	46	26	30	20	31	9	13	7	12	16,312,000
Mississippi	12	11	5	3	....	....	....	....	....	....	15,528,000
Montana	19	14	13	11	....	15	....	3	....	....	7,440,000
Nebraska	4	5	3	4	2	2	....	....	....	....	1,785,000
New Mexico	48	46	42	44	30	32	....	....	....	....	39,109,000
New York	77*	71*	67*	71*	70	75	....	....	....	....	5,180,000
Ohio	51	48	44	41	31	36	....	....	....	....	3,342,000
Oklahoma	122	118	111	109	47	59	15	18	76	88	154,817,000
Pennsylvania	164*	153*	156*	150*	149	164	....	....	....	....	16,700,000
Texas	506	412	421	394	263	257	382	406	367	360	501,745,000
West Virginia	36	47	31	45	39	44	11	14	13	20	3,418,000
Wyoming	2	2	....	1	2	3	1	1	1	1	29,952,000
Total	1682	1554	1447	1408	917	896	588	629	696	680	1,398,485,000

*Includes water-intake and pressure wells.

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Photo by U. S. Army Signal Corps

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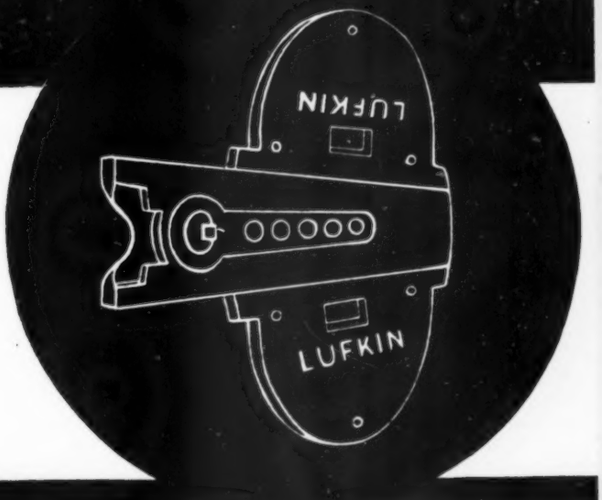

LUFKIN PUMPING UNITS

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MAJOR *Refining* ACTIVITIES

CONSTRUCTION has been resumed on The Phillips Petroleum Company synthetic rubber plant recently suspended because of a discussion in Washington, D. C., concerning the synthetic rubber problem and an investigation of the Houdry process. The plant is expected to have an annual output of 45,000 tons of butadiene, vital ingredient of synthetic rubber. Production by the plant is expected to begin in April, 1943.

The Phillips Petroleum Company has contracted with the Defense Plant Corporation and the Rubber Reserve Company to design, construct, and operate a plant for the manufacture of butadiene. The War Production Board has issued the highest preference rating for the procurement of necessary material. This is according to a statement released by Frank Phillips, chairman of the board of The Phillips Petroleum Company.

Phillips further stated that six months' work has already been done on the plant with approximately $12,000,000 of material ordered. Also, that simultaneously with the completion of butadiene plant, a styrene and a synthetic rubber plant at the same location will be completed forming a complete synthetic rubber producing unit. Within less than 8½ months from the completion dates of the plants more than 50,000 long tons of synthetic rubber will be produced per year, it is stated. Phillips said this amount of rubber would make about 11,000,000 tires to relieve the shortage of rubber.

Shamrock Oil and Gas Corporation is revamping the poly gasoline unit at its Sunray refinery at Dumas, Texas, to enable the company to produce, in addition to gasoline, cumene or *iso*propyl benzene, which is a basic element in the manufacture of aviation gasoline. Completion of the changes is expected by September 1. It is reported that the changes will not interfere with the continuous production of poly gasoline and other products.

Announcement has been made from the office of the National Refining Company, Cleveland, Ohio, that a new 100-octane aviation gasoline plant is to be constructed in Coffeyville, Kansas. This plant will be financed by the Defense Plant Corporation, subsidiary of the Reconstruction Finance Corporation, at a cost of several million dollars. The National Refining Company will operate the plant.

Construction supervision of the new unit will be by Arthur G. McKee Engineering Company of Cleveland, Ohio. Construction of the plant is expected to begin within the next two months with the plant to be ready for operation by about June 1, 1943, according to a representative of the refining company.

The present refinery owned and operated by the National Refining Company at Coffeyville has a crude oil capacity of 9500 bbl. per day with the cracking facilities rated at 2500 bbl. per day.

A plant for the production of butadiene, being built for the Government by Shell Oil Company, Inc., is expected to be completed by the middle of 1943, it was announced in New York recently by R. G. A. van der Woude, president of Shell Union Oil Corporation.

Shell completed its first plant for the manufacture of butadiene several months before the entry of the United States into the war. The company is also continuing to produce toluene for explosives, and is active in the manufacture of aviation gasoline. According to van der Woude, the company was the first to begin commercial production of a new blending synthetic having a special antiknock quality in supercharged aviation engines. The new synthetic provides a means for immediately increasing the production of high-octane gasoline by about 20 percent, as it can be manufactured in existing facilities with minor changes, and will require only a small amount of critical materials.

The Ohio Farm Bureau Coöperative Federation has adopted plans for extending its activities into the refining industry, it has been announced by trustees. The organization now operates 60 local bulk plants, 175 petroleum delivery and transport trucks, and, in conjunction with other regional coöperatives, two oil-blending plants. This will be its initial entry into the refining field.

Frontier Refining Company, Cheyenne, Wyoming, has contracted for an enlargement of its plant in that city from 1600 to 3500 bbl. per day of aviation gasoline. Reports state that priorities have been granted and that the Defense Plant Corporation will finance the plant conversion and expansion. The plant is to be operated by the Frontier company under a management agreement.

The present supply of crude oil from the Minnelusa Oil Corporation's holdings in Lance Creek will be supplemented by additional crude oil from Salt Creek holdings of Standard Oil Company of Indiana. Gas-oil and butylene fractions will be supplied by the Continental Oil Company, Bay Petroleum Corporation, Perry Petroleum Corporation, and other independent firms of the State.

Expected to cost approximately $4,000,000, the additions to the plant will require about eight months to construct.

According to officials, approval has been given to plans of the British American Oil Producing Company for conversion of its existing equipment at Moose Jaw, Saskatchewan, Canada, to the manufacture of aviation gasoline. The conversion is expected to cost approximately $250,000. Construction will begin as soon as some necessary equipment has been procured from the United States.

Crude Runs to Stills, Gasoline, Gas and Fuel Oil Stocks
Week Ended August 1, 1942
A.P.I. Figures
(Figures in thousands of bbl. of 42 gal. each)

DISTRICT	Percent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks	Total Gas and Fuel Oil Stocks
*Combined: East Coast, Texas Gulf Louisiana Gulf, North Louisiana-Arkansas, and Inland Texas	89.7	1,660	69.7	38,442	36,226
Appalachian	84.5	152	87.4	2,624	1,175
Ind., Ill., Ky.	84.9	742	94.6	15,250	8,207
Okla., Kans., Mo.	81.1	365	87.3	7,381	2,862
Rocky Mountain	50.7	92	66.7	2,151	958
California	90.9	661	84.0	15,476	66,485
TOTAL U. S.—B. OF M. BASIS AUG. 1, 1942	86.9	3,672	78.4	(a)81,324	115,913
TOTAL U. S.—B. OF M. BASIS JULY 25, 1942	86.9	3,658	78.1	82,281	112,782
U. S. B. OF M. BASIS AUG. 2, 1941		3,868		84,668	135,504

(a) Finished, 73,578,000 bbl.; unfinished, 7,746,000 bbl.

*At the request of the Office of Petroleum Co-ordinator.

THE Petroleum Engineer

AUGUST, 1942

Cements for Oil and Gas Wells

Exclusive

☆ An evaluation of present knowledge of the properties and behavior of cements used in exclusion of water from oil and gas wells, with references to the recent literature

PART 1

by Lester C. Uren

Professor of Petroleum Engineering,
University of California

FOR many years it has been customary to cement casing in oil and gas wells as a means of excluding water from formations penetrated by the drill. Cement plugs are also formed in wells to aid in side-tracking and hole-straightening operations, to provide a "bridge" for sealing-off the lower part of a well, to control escape of gas into and through the well and to provide security against displacement of well equipment under the high pressures frequently imposed. For three decades, oil producers have recognized that these uses of cement are unique and require special consideration of the unusual conditions under which such operations are conducted and of the qualities of cements that make them best adapted to contend with the conditions imposed.

Early use of cement in well-drilling operations was without much knowledge on the part of the oil producers either of the qualities of the cements used or of the subsurface conditions imposed. Naturally, the cement often failed to accomplish the purpose intended. The first comprehensive treatment of oil-well cementing practices in the literature was published by the U. S. Bureau of Mines in 1918. In its bibliography, this publication lists only 11 comparatively unimportant papers on the subject printed prior to this time, the earliest of which is dated 1911. The earliest patents governing the art of cementing casing in wells are dated 1910. Since then, and within the memory of many men active in the petroleum industry today, there has developed a very important and highly technical phase of petroleum technology concerned with the use of cements in oil and gas wells. In the development of hundreds of oil and gas fields, every well requires one or more cementing operations. Thousands of tons of cement are used annually for this purpose and the petroleum industry has become one of the cement industry's best customers. Every petroleum engineer is concerned in some degree with oil-well cementing operatons. Large service organizations with millions of dollars worth of specialized cementing equipment, employ many hundreds of men who give their entire time to this work.

With the development of this art, have come vastly improved cementing equipment and methods of conducting the work, a superior knowledge of the cements employed, and a knowledge of their behavior under the unusual conditions prevailing in deep wells. Interest

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in this subject has been widespread. Technologists in the employ of many oil companies, oil-industry service organizations, cement manufacturers, and government and other institutional agencies have contributed to our knowledge of cements and their use in oil and gas well service. Many research projects have had as their objective a better understanding of the behavior of cements under deep-well conditions and of methods of determining the properties of cements that make them more or less successful in this type of work. This research, begun 20 years or more ago, is still continuing to yield new and useful results and recent work in this field has been productive of information of great value and importance to oil producers. It is of the progress made during these last few years and of the expanding knowledge of cement technology arising therefrom, that this article is primarily concerned. Many papers appearing in the literature during recent years have dealt with the mechanical and physical problems incidental to the placement of cement in oil wells and with the methods and equipment employed. We shall not be concerned with these in the present article, directing our attention rather to the behavior and properties of the cement and the conditions that influence its successful use in oil-well service.

Properties of Portland Cement

Varieties of Portland cement may satisfy all ordinary requirements in oil-well service. Portland cement is manufactured by a process involving the sintering of a mixture of clay and limestone in certain proportions. The cement clinker possesses no hydraulic properties until it is finely ground. During the grinding process, calcium sulphate (gypsum) is added in carefully regulated amounts to control the setting time.

Cement chemistry is complex and one of the principal contributions of research in this field during recent years has been a clearer concept of the chemical constitution of Portland cement and of the changes that occur when it is hydrated. Chemical analysis of Portland cement[2b] discloses that it is composed of a mixture of calcium oxide (CaO), aluminum oxide (Al_2O_3), silicon dioxide (SiO_2), magnesium oxide (MgO), ferric oxide (Fe_2O_3), and sulphur trioxide (SO_3) in varying amounts depending upon the composition and quantities of the source materials used in manufacture. To these essential constituents, might be added potassium oxide (K_2O), sodium oxide (Na_2O), manganese oxide (Mn_2O_3), and perhaps other oxides that are frequently present to the extent of 2 percent or less.[17]

The constituents thus disclosed by chemical analysis do not afford a dependable index to the subsequent behavior of the cement. The manner in which these different oxides are combined to form various siliceous and aluminous compounds that go to make up the calcined material, affords a better guide.[15] Phase equilibrium studies indicate that the various oxides shown by chemical analysis are present in combined form as tricalcium silicate ($3CaO.SiO_2$), dicalcium silicate ($2CaO.SiO_2$), tricalcium aluminate ($3CaO.Al_2O_3$), tetracalcium aluminoferrite ($4CaO.Al_2O_3.Fe_2O_3$), and gypsum ($CaSO_4.2H_2O$). Pentacalcium trialuminate ($5CaO.3Al_2O_3$) and dicalcium ferrite ($2CaO.Fe_2O_3$) may also be present, but are not essential constituents. Knowledge of the relative amounts of these different compounds present in a cement will enable the cement technologist to predict its behavior after hydration.

Hydration, Setting, and Hardening of Cement

The chemical changes that occur after finely ground Portland cement has been mixed with water and which produce the phenomenon known as "setting," are complex and still somewhat uncertain. Most authorities agree, however, that the setting of cement occurs in stages involving first, the hydration of tricalcium aluminate and perhaps some alumina. These products are amorphous at first, but later when the cement is said to take its "initial set," crystals of tricalcium aluminate are formed, along with crystals of calcium sulfoaluminate, the sulphur in the latter compound being contributed by the gypsum. Any free lime present is also hydrated. The calcium silicates hydrate less rapidly, but within a day begin to form crystals of calcium oxide and a colloidal gel consisting of calcium silicate and silica hydrate. Hydration of the calcium silicates is not ordinarily complete within 28 days.

As hydration progresses, the cement gradually hardens and acquires strength. It is believed that the phenomenon of setting is an expression of early crytallization and consolidation resulting from hydration of the tricalcium aluminate and partial hydration of the tricalcium silicate.[15] Later increase in strength is due to continued hydration of the tricalcium and dicalcium silicates. Neither the tricalcium aluminate nor tetracalcium aluminoferrite contribute much to the ultimate strength of the cement. The latter, however, gives protection against the destructive influence of sulphate ground waters, which react with hydrated tricalcium aluminate to form compounds causing expansion and disintegration of hardened cement. The fluidity of the slurrified cement, before solidification occurs, is chiefly influenced by the dicalcium silicate and tricalcium aluminate.[20]

From the physical point of view, three periods are recognized in the hydration of Portland cement: the so-called "initial set," the "final set," and the hardening period. The changes that characterize these different periods are the result of chemical readjustments that, as explained above, require time to achieve. The initial set is said to have occurred when the cement slurry has lost its plasticity and become friable to such a degree that two pieces of a broken specimen will not unite to form a homogeneous mass when placed in close contact. After the initial set has occurred, the cement undergoes further chemical change, as a result of which it acquires greater hardness until the final set has been achieved. It is arbitrarily defined as that condition when a certain degree of rigidity is attained, as determined by a penetration needle of standard proportions. With most Portland cements, the final set occurs in from two to five hours after the initial set. It is of no particular significance in oil-well cementing. Following the final set, further chemical readjustments throughout a period of about 28 days result in a gradual increase in strength and hardness.

Accelerators. The time of final set is somewhat diminished and the period of hardening is reduced to as little as three or four days by adding a chemical accelerator, either to the cement or to the water used in preparing the slurry. A variety of accelerators are available on the market under different trade names, but calcium chloride is the active agent in nearly all of them.[1] Other reagents that may be used to accelerate the setting time include calcium oxychloride, sodium or potassium hydroxide, and calcium silicate. In the so-called "high-early-strength cements," a chemical accelerator is intimately mixed with the cement by the manufacturer, but a similar result may be had by dissolving the accelerator in the water used in gauging the cement in the field. Calcium chloride may be used in this way to the extent of 2 or 3 percent; or, 3.5 lb. of calcium chloride may be dissolved in each cu. ft. of water used. Addition of such an amount of calcium chloride causes rapid hydration of the cement and a more rapid set with high early strength and often greater ultimate strength. The thickening-time of the cement slurry is not adversely influenced by addition of calcium chloride in moderate amounts, but use of more than 3 percent may hasten the thickening rate and generally reduces the ultimate compressive strength and should therefore be avoided.

Retarders. For use in deep wells

where unusually high temperatures are encountered, the cement may set so rapidly that it becomes necessary to resort to the addition of retarding agents that prolong the setting time. Gypsum, sugar, lime, various gums and organic compounds, such as sodium tannate, may be used for this purpose. The time of thickening, setting and hardening may also be prolonged in the process of manufacture by coarser grinding of the cement clinker, or by altering the chemical composition. Use of ice water in mixing cement will also reduce slurry temperature and thus prolong the setting time.

Influence of Fineness of Grinding

The setting qualities of Portland cement are influenced markedly by the degree of fineness to which the material is ground. Most cements are ground so that all but 2 or 3 percent of the material will pass through a 100-mesh screen, and about 85 percent will usually pass 200 mesh. The particles coarser than 100 mesh are probably inert and have no hydraulic properties. Cement particles coarser than 64 microns (250 mesh) hydrate so slowly that for all practical purposes they contribute very little to the setting properties.[4]

A screen analysis of cement does not provide as satisfactory an index of setting qualities as does a measure of the specific surface presented by its component grains. The size distribution of grains is also of interest in this connection. A method for determining these factors employs a type of turbidimeter[2f] in which a photo-electric cell and microammeter are used to measure the amount of light passed per unit of time from a light source of constant intensity through a suspension in kerosine of a standard amount of cement. A known relationship between the magnitude of current flowing through the microammeter and the specific surface of the suspended material enables one to estimate quickly the surface area of the cement particles. This is customarily expressed in sq. cm. per gram. Specific surfaces of various Portland cements are found to range from 1100 to upwards of 2800 sq. cm. per gm. Particle size-distribution is estimated by observing changes in turbidity as the cement particles settle from suspension. The settling-time intervals are converted to particle sizes by application of Stokes' Law.

Heat of Hydration of Cement

Chemical reaction of water upon the constituents of Portland cement in the process of setting develops considerable heat.[15] Calorimeter tests indicate that the amount of heat liberated by hydration of cement ranges from 60 to 115 calories per gram, depending upon its composition and fineness of grinding. Liberation of heat apparently reaches a maximum in from 4 to 8 hours after the cement is mixed, or shortly after the initial set occurs, and may produce temperatures in the cement as great as 50°F. above that of the surrounding formations. Liberation of heat continues to a lesser extent during the subsequent period of hardening, however, and is conducted away very slowly. Temperature surveys in wells inside of cemented casings, disclose higher-than-normal temperatures in cemented intervals for a period of several days after the cement has been placed. Tricalcium aluminate is the constituent responsible for most of the heat, though hydration of tricalcium silicate is also an exothermic reaction. The heat of hydration is apparently of little significance in the use of cement in oil and gas wells, though a critical factor in some types of surface construction. In the well, the heat of hydration does not develop rapidly enough to influence the thickening time and setting time of cement, but will be helpful in hastening the final set and hardening process.

Cement Tests and Specifications

A.S.T.M. specifications and tests. The recognized authority on specifications and tests for cements is the American Society for Testing Materials. The requirements set by this organization have been the principal guide for cement manufacturers and large buyers in the United States for many years. The most recent edition of "Standard Specifications for Portland Cement," adopted by the A.S.T.M. in 1941, recognizes five types of Portland cement, as follows:[2a]

Type 1. For use in general concrete construction where special properties of other types are not required.

Type 2. For use in general concrete construction exposed to moderate sulphate action or where moderate heat of hydration is required.

Type 3. For use when high early strength is required.

Type 4. For use when a low heat of hydration is required.

Type 5. For use when high sulphate-resistance is required.

For each of these types, definite maximum or minimum percentages of the different oxide components as indicated by chemical analysis are prescribed and for some types limiting values for the constituent silicates and aluminates. For each type, also, are prescribed physical requirements, including fineness, soundness, initial and final setting time, and tensile and compressive strengths.[2d] The methods by which chemical analyses shall be made and each of the physical tests performed, are also prescribed.

A.P.I. Tentative Code. Because cement used in oil-well operations is subjected to higher temperatures, is necessarily gauged with a larger percentage of water and is subjected to more agitation prior to setting than cement used in surface construction work, it is found that the specifications and tests prescribed by the American Society for Testing Materials are not altogether appropriate and do not completely define the desirable properties nor the methods of determining them.[28] A committee of the American Petroleum Institute has during recent years been studying the conditions of use of cements in oil-well service and has proposed certain additional or alternate tests designed to indicate suitability of cement for oil-well purposes. A tentative code has been proposed but as yet has not been formally approved.[21] Nevertheless, some of the tests proposed have already attained wide use in the petroleum industry and may be regarded as a probable basis for the cement-testing code that the A.P.I. will eventually adopt. A sieve test that involves passing a sample of the cement through a 30-mesh screen to disclose the presence of lumps or coarse foreign materials is proposed. A "ring test" designed to provide a rough index of fluidity and pumpability of cement slurry is suggested, but some operators and cement technologists express dissatisfaction with this test, asserting that it does not yield reproducible results in the hands of different operators, and is not necessarily the best guide in determining the proper percentage of water to use in field-mixed slurries. Tensile strength tests are suggested rather than compressive strength tests,[28] because the equipment for tensile strength is less expensive and more commonly available in field laboratories. A foam test is also suggested as a means of identifying cements that will form excessive amounts of foam during the process of gauging with water.

Probably the most useful and unusual test proposed by the A.P.I. Cement Committee is the "thickening-time test." This is designed to indicate the allowable time, after a cement has been mixed with water, before the slurry increases in viscosity to such a degree that it is no longer pumpable.[18] Two different types of instruments are available for this test and though only developed during recent years, both now find wide use in the petroleum industry. These are (1) the "ice-cream-freezer-type" of thickening-time tester developed by technologists of the Standard Oil Company of California and used almost exclusively by California oil producers, and (2) a consistometer used by the Halliburton Oil Well Cementing Com-

pany and many oil producers of the Mid-Continent and Gulf Coast areas of the United States.[34] Both instruments serve the same purpose and provide for conduction of the thickening-time test in much the same way, but express viscosity of the cement slurry in different units and prescribe different temperature conditions for the test. An improved type of consistometer developed by technologists of the Stanolind Oil and Gas Company provides means for controlling the pressure to which the cement slurry is subjected as well as the temperature.[10] In the conduction of thickening-time tests with this instrument, an effort is made to reproduce in the tester the pressure and temperature conditions to which the cement slurry will be subjected during placement in the well, meanwhile obtaining a record of changing slurry consistency.

Influence of Deep-Well Conditions

In any discussion of oil-well cements and their use in field service, one must keep in mind the bottom-hole conditions existing within the well that influence the cement behavior. Pressures of many hundreds of pounds per square inch are imposed by the well fluid (50 lb. or more per 100 ft. of depth). The temperature is often far above normal atmospheric temperature (often about 1°F. for each 50 ft. of depth). The methods of placement employed require that the neat cement slurry be of such consistency that it can be passed readily through pumps. This ordinarily means that the amount of water used shall be 40 percent or more of the weight of the cement and methods of placement often permit of further dilution by the well fluid. In the well, the cement slurry is usually contaminated to some extent with mud and perhaps also with oil. The cement slurry is often maintained in turbulent flow through pumps and pipes for a half hour or more after it is gauged with water. Gas blowing through the slurry after it has reached its intended position in the well may keep it agitated until the initial set occurs. Saline ground waters from strata penetrated by the well may alter the setting properties of the cement. Certain sulphate waters may make the cement "unsound" after it has set. Permeable formations penetrated by the well may absorb some of the water from the cement slurry. Any of these conditions may seriously alter the setting properties of cement so that it does not satisfactorily perform its intended function.

EDITOR'S NOTE: This article will be continued in an early issue.

Bibliography

Space does not permit of printing the extensive bibliography that would be necessary to note all worth-while sources of information on the subject of cements and their use in oil-well service. The following list presents a selection from the publications of the last eight years. A list of 83 publications[20] that appeared prior to this time will be found in Volume 21 (1935) of the *Journal* of the Institution of Petroleum Technologists (London), pages 734-740. An excellent bibliography on oil-field ground waters will be found in the Bulletin of the American Association of Petroleum Geologists, May, 1942, pages 865-881.

1. "Effect of Calcium Chloride in Oil Well Cements," by F. N. Alquist and H. H. Miller, *Oil and Gas Journal*, July 17, 1941, p. 42.
2. American Society for Testing Materials,
   (a) "Standard Specifications for Portland Cement," A.S.T.M. Designation C-150-41.
   (b) "Standard Methods of Chemical Analysis of Portland Cement," A.S.T.M. Designation C-114-40.
   (c) "Tentative Methods of Chemical Analysis of Portland Cement," A.T.S.M. Designation C-114-40T.
   (d) "Standard Methods of Sampling and Physical Testing of Portland Cement," A.S.T.M. Designation C-77.
   (e) "Tentative Method of Test for Compressive Strength of Portland Cement Mortars," A.S.T.M. Designation C-109.
   (f) "Tentative Method of Test for Fineness of Portland Cement by Means of Turbidimeter," A.S.T.M. Designation C-115.
   (g) "Tentative Method of Test for Autoclave Expansion of Portland Cement," A.S.T.M. Designation C-151.
3. "Aquagel Cement for Oil Wells," "Drilling Mud," Baroid Sales Company (Los Angeles, California), January-February, 1934, pp. 1-11.
4. "Fineness and Water-Cement Ratio in Relation to Volume and Permeability of Cement," by J. R. Coleman and G. L. Corrigan, *A.I.M.E. Petroleum Development and Technology, 1941*, pp. 205-215. See also, *Petroleum Technology*, January, 1941.
5. "Studies of Well Cement," by J. R. Coleman and G. L. Corrigan, *International Oil*, July, 1941, pp. 25-33.
6. "Testing Oil Well Cement," by G. L. Corrigan, *International Oil*, January, 1942, pp. 49-56.
7. "Effect of Temperature, Pressure and Water-Cement Ratio on the Setting Time and Strength of Cement," by B. C. Craft, T. J. Johnson, and H. L. Kirkpatrick, *A.I.M.E. Petroleum Development and Technology, 1935*, pp. 62-68.
8. "Specifications for Oil-Well Cement," by E. L. Davis, *A.P.I. Drilling and Production Practice, 1938*, pp. 372-376.
9. "Effects of Temperature and Pressure on Rheological Properties of Cement Slurries," by R. F. Farris, *A.I.M.E. Petroleum Development and Technology, 1941*, pp. 117-130.
10. "A Practical Evaluation of Cements for Oil Wells," by R. F. Farris, *A.P.I. Drilling and Production Practice, 1941*, pp. 283-292.
11. "New Fast-Setting Cement is Valuable Odd-Job Adjunct," by R. K. Henderson, *The Petroleum Engineer*, September, 1940, p. 93.
12. "Detection of Radioactive Cement in Cased Wells," by L. G. Howell and A. Frosch, *A.I.M.E. Petroleum Development and Technology, 1940*, pp. 71-78.
13. "Fibrous Materials in Cement and Mud Opens New Field in Production Practice," by H. N. Ihrig, *Oil and Gas Journal*, May 21, 1936, pp. 98-100.
14. "Factors Influencing Bond Between Cement and Formation," by P. H. Jones and D. Berdine, *A.P.I. Drilling and Production Practice, 1940*, pp. 45-63.
15. "The Chemistry of Cement and Concrete," by F. M. Lea and C. H. Desch, Edward Arnold and Company, London, England.
16. "Loss of Cement Slurry Combated by Use of Cellulose Filler," by G. L. Leach, *The Petroleum Engineer*, December, 1940, p. 94.
17. "Oil-Well Cements—Chemical Composition and Sensitiveness to Additions of Water," by S. L. Meyers, *The Petroleum Engineer*, September, 1939, p. 100.
18. "Some Factors Controlling the Pumping Time of Oil-Well Cements," by G. R. Neighbors and S. Cromer, *A.I.M.E. Petroleum Technology*, November, 1941, Tech. Pub. 1399.
19. "Use of Bulk Cement in Wells," *The Petroleum Engineer*, July, 1940, p. 74.
20. "Bibliography on Oil-Well Cement," by A. Reid, *Journal, Institution of Petroleum Technologists*, Vol. 21, p. 734, 1935.
21. "Cement for Oil Wells: Status of Testing Methods and Summary of Properties," by W. W. Robinson, *A.P.I. Drilling and Production Practice, 1939*, pp. 567-591. See also *The Oil Weekly*, issues of August 21 and 28, 1939.
22. "Sulphate-Resistant Cement," by S. Rordam and C. Willson, *A.I.M.E. Petroleum Technology*, February, 1939. Tech. Pub. 1029. See also, *Transactions, American Society for Mechanical Engineers*, April, 1938,
23. "Gel-Cement, Its Use and Application in Drilling Wells," by W. A. Sawdon, *The Petroleum Engineer*, April, 1935, pp. 29-31.
24. "Use of Oil-Well Cement Containing Prepared Bentonite," by W. A. Sawdon, *The Petroleum Engineer*, March, 1939, p. 33.
25. "Acid-Soluble Cement as an Aid in Increasing Flow Through Gun Perforations," by W. A. Sawdon, *The Petroleum Engineer*, January, 1941, p. 33.
26. "Use of Sand in Oil-Well Cement," by W. A. Sawdon, *The Petroleum Engineer*, March, 1941, p. 23.
27. "Cement Slurry to Fit the Job," by W. A. Sawdon, *The Petroleum Engineer*, April, 1942, p. 23.
28. "Special Factors Must be Considered in Selection, Specification and Testing of Cement for Oil Wells," by D. E. Silcox and R. B. Rule, *The Oil Weekly*, July 29, 1935, p. 21.
29. "Oil Well Cementing," by J. R. Suman, pages 211-222 of a book entitled, *Elements of the Petroleum Industry*, published by A.I.M.E., 1940.
30. "Correcting Cement Failures," by P. D. Torrey, *International Oil*, October, 1940, pp. 24-35.
31. "Bulk Cementing, an Important Improvement in Cementing Practice," by P. D. Torrey, *International Oil*, January, 1941, pp. 80-81.
32. "Use of Acid-Soluble Cement in Cementing Oil and Gas Wells," by R. L. Tracy, *Oil and Gas Journal*, September 25, 1941.
33. "Oil Field Development," by L. C. Uren, pp. 368-392. McGraw-Hill Book Company, New York, New York, 1934.
34. "Determining Suitability of Cement for Oil-Well Cementing," by J. E. Weiler, *The Petroleum Engineer*, September, 1938, p. 33.
35. "Gel-Cements and Their Application in Oil-Well Cementing Operations," by C. Willson, *A.P.I. Drilling and Production Practice, 1941*, pp. 293-302. See also *Oil and Gas Journal*, April 10, 1941, p. 45, and *The Oil Weekly*, April 28, 1941, p. 21.

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Progress in Reservoir Technology

PETROLEUM ENGINEER Exclusive Feature

☆ During the last decade the petroleum industry has learned intimately, for the first time, the nature of the oil reservoir

PART 1

by Morris Muskat

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AT first thought neither the year 1941 nor 1931 would appear to be of such unusual significance as to warrant a special review of the progress of reservoir technology in this particular time interval. Yet little imagination is required to visualize 1941 as the end of an epoch in the development of reservoir engineering, as indeed it is in the progress of many other phases of American industrial activity. One does not need to be divinely prophetic to anticipate a future for the oil industry, following our successful conclusion of the war, which will not continue simply as a smooth extrapolation from its peace-time growth in the immediate past. Whatever the character of the script or the titles of the chapters may turn out to be, a new book was undoubtedly begun in the historical record of American industry on the morning of December 7, 1941. That same morning wrote "finis" to the last volume of our peace-time history, and it is not inappropriate to turn back some of the pages of this volume and read what the hands of time have written therein.

Although the date of the closing of this volume will certainly be agreed upon by everyone who has not been indulging in a Van Winklian reverie, the suggestion that it began in 1931 perhaps involves somewhat more of the personal equation. Indeed the choice of this beginning is rather arbitrary; 1930 or 1932 might well lay equal claim to the honor of the first entry into the record of our recent progress. Yet it certainly was around 1931 that the subject of oil reservoir technology really began to emerge from its infancy. In fact, it is because the rate of progress at this time was so slow that its actual beginning is difficult to discern.

At the beginning of this decade, whether it be chosen as 1930 or 1931, reservoir technology was hardly more than an abstract phrase. No standardized techniques had been developed for the determination of either the characteristics of oil-bearing rocks or of the properties of oil reservoir fluids. The mechanics of oil production was still regarded as a simple application of hydraulic engineering. The principles of secondary recovery were only just beginning to emerge from the water-flooding experiences in the Bradford district and scattered repressuring projects in the Gulf Coast area. The significance of the water-drive as an effective agent for oil recovery had in no wise been appreciated. The possibility that Kettleman Hills constituted not merely a grotesque perversion of hydrocarbon thermodynamics, but represented rather a typical example of a new and important class of petroleum reservoirs, was hardly even anticipated. The problem of well spacing was enslaved under the rule of capture. The impact upon industry of restrictive legal regulations, such as proration, was even beyond the scope of fantasy. Principles and practices of conservation and utilization were scarcely more than a well-meaning jargon considered as foreign to an activity as highly competitive as the oil industry. Such was the situation at the beginning of this decade of progress.

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Core Analysis

The developments during the last decade have been so extensive and far-reaching that it is difficult to understand the success that the industry enjoyed prior to this period. Is there a professional production engineer or petroleum geologist today who evaluates a saturated oil horizon solely on the basis of its porosity? Yet that was the common and generally accepted criterion for such evaluation ten years ago. It is true that the petroleum literature before 1931 records a few experiments of the type that would now be termed permeability measurements; but the experimental techniques used in those days in the oil industry were so poor that the results at the best had only an order-of-magnitude significance. Indeed it is only since 1931 that the determination of the permeability of oil sands has developed into a scientific technique whereby values can be obtained that are independent of the time, and also of the individual or organization carry-

ing out the experiments. This scientific technique is now so well established that its basic principles have been codified and standardized. The permeability of a sand has thus become a well defined and precise measure of the capacity of the porous medium to transmit homogeneous fluids. It provides a quantitative yardstick whereby one may compare different sands with respect to their inherent ability to *produce* oil, in contrast to the porosity that measures the sand merely as a potential container of oil. The tremendous stratification of productive zones from the standpoint of the productive capacity is thus immediately explicable. For, whereas sand porosities generally vary by a factor of no more than 4 or 5, the permeabilities of adjacent oil-bearing strata frequently vary by factors as great as 100. This observation is given a ready explanation upon noting that whereas the porosity is determined essentially by the nature of the packing of the sand grains, the permeability depends mainly on the grain size and grain size distribution. In fact, both theory and experiment has demonstrated that the permeability is proportional to the square of the effective grain size.

The porosity and permeability of reservoir rocks represent only two items of data now generally provided by the group of procedures termed core analysis. For these latter also include measurements relating to the fluid content of cores. In a gross qualitative sense such determinations indicate whether the particular strata cored are gas-bearing, oil-bearing, or water-bearing. Quantitatively they tell much more of a story, for they show just how much of the pore space of a rock is occupied by these various fluid components. Here we find one of the most important and significant developments in reservoir technology in the last decade. For it still was a common assumption, prior to this period, that a virgin oil sand was just that, namely, one fully saturated with oil. The same applied to so-called gas sands and, of course, water-saturated strata were conceived to be literally water-saturated. Considering in retrospect what we now know about the flow of heterogeneous fluids through sands, and in view of the previous development of the theory of oil accumulation by migration, it is difficult to understand the persistence of these naive concepts. Yet it was only as a result of direct laboratory experimentation with oil-field cores that the industry was brought to realize the almost universal association of connate or interstitial waters with petroleum fluids. That is, we know now that although the porosity still measures the volumetric capacity of a rock to contain oil or gas, it almost literally never is fully saturated with these fluids even under virgin conditions. Indeed, the determining factor controlling the nature of the actual production of fluids from reservoir strata is the *relative* distribution of at least two of the fluids, such as oil and water, or gas and water, rather than the mere presence of any one of them in the rock. In fact, we know now that sands may produce for extended periods of time so-called "clean" or pipeline oil, even though the virgin sand contained enough water to fill half the pore space. Conversely, a sand may originally have an oil saturation as high as 20 percent and yet produce nothing but brine. The implications of this type of data obtained by core analyses are obviously far-reaching. Observations of mere oil staining in drill cuttings must now be weighed carefully and with extreme caution. Together with data on the permeabilities of the various strata saturated by the drill, this additional information regarding the fluid distribution provides an almost indispensable guide for the proper completion of a producing well. And obviously the calculation of reserves in terms of the pore space of the reservoir, takes on a new significance when account is taken of the actual fluid distribution within the rock strata.

Of course, the subject of core analysis cannot be considered as a closed chapter in our volume of progress; it is still beset with difficulties and problems for solution in the future. These are related to the fact that the core analyses have to be performed on rock samples at the surface and hence involve the translation of the conditions as observed at the surface to those that existed in the sand before it was penetrated by the drill. For in the process of sampling the virgin rock, the latter must undergo both the mechanical ordeal of excision and the perhaps equally exhausting experience of the dissipation of its original pressure.

Some progress has been made in meeting this latter problem. For by direct laboratory experimentation one can find out what will happen to a core saturated with petroleum fluids at high pressure as the pressure is released. Moreover, in the last several years methods have been developed for obtaining the cores under pressure so as to be able to follow the effect of pressure reduction on the actual cores at the surface. Nevertheless, the uncertainty still remains regarding the effect of the process of drilling on the rock sample as it enters the core barrel. Special tracer studies have confirmed what could be anticipated on the basis of general considerations, namely, that as a rule the drilling fluid will penetrate the core and displace some of the original fluids in it. Hence, even with the pressure core barrel, at its present stage of development, one can obtain only a sample of the reservoir rock after it has been subjected to the drilling operation and which, therefore, may well have a radically different fluid distribution than the virgin undisturbed producing section.

It is true that these deficiencies in the basic procedure underlying core analysis are not wholly unmitigated evils. For the loss of fluid from the core as it is brought to the surface in a conventional core barrel can be interpreted, with suitable qualifications, as a measure of the oil that would normally be recoverable from the rock by virtue of the gases dissolved in the virgin fluids. Moreover, the residual oil in the core when it finally reaches the surface may reasonably be taken as an indication of the oil that would remain unrecoverable, even after being subjected to the action of natural or artificial water floods. As a whole, therefore, despite its limitations, the development and application of core analysis techniques may be considered as an outstanding achievement in the process of accumulating specific information and data on the nature of oil-bearing reservoirs. In a word, it has made it possible for us to know, rather than to guess, what the producing section in any locality is really like.

A parallel and supplementary development in this period pertaining to the identification and correlation of oil-bearing rocks is the electrical logging method. This, too, is at the present time still beset with a number of limitations. Nevertheless, it certainly can lay claim to a high degree of reliability and very wide applicability in the correlation of definite horizons in individual fields. Under favorable conditions it can also serve well in the location and identification of water-bearing zones, and thus supplement the core analyses data in guiding proper well-completion methods.

Thermodynamics of Reservoir Fluids

Another related phase of the progress made in the understanding of the nature of oil-bearing reservoirs pertains to the properties of the petroleum fluids. The terms gas and oil are no longer used glibly without further specification. Of course, the techniques of measuring the gravity of natural gases and of oils have been known for a long time. But the inter-relationships between the gas and liquid phases, and the manner in which these are influenced by the properties of the separate phases, have not been fully appreciated until rather recently. Much data are now available upon the various thermodynamic properties of hydrocarbon gases and liquids. Quite general correlations have been developed for the quantitative prediction of the manner in which natural gases will deviate from

perfect gas law behavior. The determination of the solubility of the natural gases in crude oils by subsurface sampling or surface recombination has become a laboratory routine. Together with the data on the expansion of the oil due to the dissolved gases, valuable information is now available regarding the manner and efficiency of the production operations. For example, it is only as a result of such experiments that it is now generally appreciated that the original bottom-hole pressure in an oil field need not necessarily represent the saturation pressure of the gas in solution in the oil. On the contrary, some of the more important oil fields are definitely under-saturated with gas when first opened to production.

Reserves Estimation

One very important application of the new technique for studying the nature of oil-bearing rocks and of the fluid produced by them, is that which has been made in the estimation of oil reserves. Although this problem has not yet been given a completely satisfactory solution, its present status is far advanced over that obtaining at the beginning of the decade. At that time the method in general use was that of extrapolating the production or pressure history curves to such times as it appeared the reservoirs would be depleted, so far as profitable operation was concerned. Such extrapolations were obviously based on the premise that the course of the future operations would remain substantially the same as they had been up to the time the future reserve estimates were to be made. To the extent that this premise was not violated, the extrapolations were fairly reliable and satisfactory; indeed, the common method of semi-logarithmic plotting frequently did give linear production histories throughout the entire producing life of the fields. The validity of this premise soon became nullified, however, as the introduction of advanced production methods, such as pressure maintenance and gas-oil ratio control, became more prevalent, and especially as the severe restrictions of proration no longer permitted wide open flow operations. Pressure declines were retarded, and, in many cases, completely eliminated for extended periods in the producing life of the oil reservoirs. Simple empirical extrapolations thus became very hazardous or entirely meaningless.

This breakdown of the earlier methods of treating the reserve estimation problem has been alleviated, at least in part, by the progress made in determining the basic properties of reservoir rocks and their entrained fluids. For we now have two rather independent procedures for reserves estimation that do not depend upon a mere intuitive extrapolation of the early production history of a field. In the first, which may be termed a static method, one simply estimates the total volume of the original oil from a knowledge of the physical dimensions of the reservoir, namely, the productive acreage and the thickness of the producing formation. When these overall dimensions are supplemented by the core analyses data regarding the average sand porosity and the original degree of oil saturation of the producing formation, one thus has a value for the total volume of oil originally present in the reservoir. Applying to this result a recovery factor representing the fraction of the original oil volume that is economically recoverable, the total recoverable reserves of the field are obtained.

The principle of this method is not new; however, the fact that now one no longer ignores the connate water in the producing section certainly has added to its trustworthiness. Moreover, better estimates can now be made regarding the recovery factor in view of the accumulated data on the older fields, and the directly determined recovery factors as measured by laboratory experiments. On the other hand, it must be admitted that the method is still subject to uncertainty and must be used with great caution and reserve.

A procedure of reserves estimation that definitely did have its origin in the last ten years is the so-called dynamical method, which has been commonly termed the material balance method. It consists essentially of applying the laws of the conservation of matter to the original constituents of the reservoir together with that of the conservation of the volume of the original producing section. The basic data used are the accumulated production of oil and gas at various time intervals, the average reservoir pressures at these time intervals, and the physical properties of the fluids produced. The latter, as previously mentioned, are the solubility of the gas in the oil, the expansion of the oil due to the dissolved gas, and the deviation from ideal behavior of the gas in equilibrium in the oil. The decline in pressure for a given gas and oil system with the withdrawal of gas and oil will obviously depend upon the total amount of oil and gas originally present, and the amount of water intrusion into the reservoir during the course of the production. On the other hand, these latter factors are just the basic unknowns that it is the purpose of the reserve estimation process to determine. The procedure, therefore, is that of guessing, varying, or, to put it bluntly, juggling the values of these unknown factors so that the theoretically calculated pressure decline curve will agree with that which has been observed. When such agreement has been achieved, it is then presumed that the true and actual values of the original gas and oil reserves are those that insure this agreement. This process of juggling is generally carried out upon the more respectable plane of theoretical calculation by means of rather imposing looking formulas. Nevertheless, in its essence it does reduce to the undignified and humble method of trial and error manipulation of the basic unknown constants until satisfactory agreement between the post-mortem predictions and the field observations is attained.

In principle such a procedure is actually no less respectable than those generally accepted for the verification and establishment of any theoretical method. As is the case in other similar situations, the accuracy of the final determinations can be no greater than that in the fundamental field and laboratory data upon which the computations are based. In order to have significant results it is, therefore, necessary that both the production and pressure data be reasonably accurate. Even then the procedure is not at all as unique as one might assume at first thought. For one thing, it is virtually necessary, in developing the appropriate formulas, to assume that the oil and gas reservoir is equivalent to a sand-free tank with uniform pressures throughout. Such uniform pressures over the producing area of a field are the exception, if any such has really ever been observed, rather than the rule. The problem of averaging variable pressures thus immediately presents itself. Then again the reserves estimation formulas of the dynamical method, which are generally used, imply that locally, as well as over the field as a whole, equilibrium exists. That this condition is satisfied in stratified formations experiencing different rates of depletion in the different strata is certainly open to question.

More important than either of these elements of uncertainty is that regarding the appropriate method of taking into account the water intrusion. For, whereas the original oil and gas contents of the reservoir are certainly invariant constants of the problem, the volume of water intrusion is obviously a variable quantity. Indeed, if it enters significantly at all into the problem, one must expect it to increase with time and with the accumulated withdrawal of oil and gas. In principle this variability in accumulated volume of water intrusion does represent a basic difficulty in the dynamical method of reserves estimation in fields subjected even to a partial water drive. For, if no physical restrictions be imposed upon its variation, it can always be so chosen that the calculated values of the original oil reserves not only remain constant during the

course of the production, but furthermore that they have any preassigned fixed value, within certain limits. In this sense the entire problem becomes indeterminate and the method breaks down. Unfortunately it is difficult to avoid this unhappy conclusion in the case of fields where water intrusion plays a major role in determining the reservoir performance. Indeed, under these conditions, because of the associated slow decline in reservoir pressure, the demands upon the accuracy of the pressure measurements also become greater and the problem of estimating reserves by material balancing becomes almost a futile gesture. On the other hand, when the water drive is only partial rather than predominant, reasonable approximations may be made in taking into account the magnitude of the water intrusion. In particular, one may suppose that the rate of the water entry is proportional to the cumulative decline in pressure, as it would be under steady state conditions. The complete indeterminacy of the functional form for the water intrusion is thus reduced to a single unknown constant of proportionality between the rate of intrusion and the pressure decline. This constant can then be treated just like those representing the original oil and gas reserves, and ultimately can be calculated or chosen so as to give agreement between the theoretical pressure decline behavior and that represented by the field observations.

Such is the present situation with regard to the problem of reserves estimation. Admittedly its solution is far from complete. Nevertheless, we are definitely further ahead today than we were some ten years ago. For in the case of the applications that have been made, values for the original oil reserves have been obtained that are entirely reasonable as judged by all the other available criteria. Moreover, when the dynamical method of reserves estimation is applicable at all, it affords a means for future extrapolation. Clearly if the constants entering the formulas, namely, those for the original oil and gas reserves and the rate of water intrusion, give agreement with the observed data during the past history of a producing reservoir, it is reasonable that they be permitted to enjoy a validity even for an extended period into the future. This is, of course, quite a different matter from that of extrapolating empirical data having no fundamental basis of correlation, simply by the criterion of smoothness and continuity. Hence, once the basic constants of the reserves estimation formulas have been determined, it is possible to calculate what the pressure decline will be in the future for preassigned values of cumulative oil and gas withdrawal. Moreover, account can be taken in such future predictions of the effect of varying the gas-oil ratios of the production, and even to the extent of returning part, or all, of the produced gas to the formation. This application is perhaps of even greater practical value than that of the primary determination of the original oil and gas content of the reservoir.

Bottom-Hole Pressure Measurements

The method of reserves estimation just outlined represents not only an important development of the general principles of reservoir technology that have been established in this last decade, but also a specific application of bottom-hole pressure measurements. Such measurements in themselves constitute a very significant advance in the study of reservoir performance. It is true that in the early days of the industry so-called pressure data were frequently taken. These generally referred to surface pressures measured at the wellheads, which could not be translated into subsurface values without detailed information regarding the pressure distribution in the flow string. As such information was not readily available, the surface pressure data were of little use in throwing light upon the details of the reservoir behavior. Now, however, there are available commercially a number of different types of subsurface pressure gauges that give with high precision either the maximum pressure obtained at the bottom of a well, or the entire pressure history at the level of the instrument for periods as long as 72 hours. By means of these gauges every major producing organization now considers it common practice not only to determine the original bottom-hole pressure when a well is first completed, but also to remeasure these pressures periodically during the course of the productive history of the reservoir.

The value of these data can hardly be overestimated, for they provide what is perhaps the most direct means for determining just what is going on in an oil-bearing formation as the result of the removal from it of oil and gas. The initial measurements made upon the completion of the discovery well directly indicate the virgin condition of the reservoir fluids. These measurements have demonstrated that in most of the shallower fields the fluid pressures in oil-bearing reservoirs initially correspond to the hydrostatic head of a column of water equal to the reservoir depth. This, in itself, is of great significance with respect to the problems pertaining to the migration and accumulation of oil. Deviations from this rule, which are frequently observed at depths exceeding 7000 ft., are also of interest from the viewpoint of the origin of the particular oil reservoir. The variations in initial reservoir pressure as observed at different wells in the same pool reflect the degree to which the withdrawals from previously drilled wells have drained the undrilled parts of the reservoir. Together with the laboratory data on the solubility of the gas in the oil, previously referred to, the reservoir pressures in the discovery wells give a direct indication of whether the oil is originally saturated with gas. This information has immediate application in determining whether the energy necessary for the expulsion of the oil is present within the oil-saturated rock itself, or must be materially supplemented by external agencies such as edgewater drives.

Bottom-hole pressure data taken over an oil field subsequent to its initial development reflect directly the mechanism of the production. When the rate of pressure decline is combined with the production data in the manner used in the dynamical method of reserves estimation, it is possible to estimate the degree to which the oil withdrawals are replaced by the evolution of the dissolved gases, the expansion of gas in free gas zones, or by the intrusion of surrounding bottomwater or edgewater. The absolute value of the pressure decline below the virgin pressure also represents a measure of the depletion of energy in the reservoir and, hence, of the depletion of recoverable oil. The pressure variations over a field, as indicated most conveniently by isobaric contours, give a graphic picture of the differential behavior over the productive area of the field. Widely spaced contours and low pressure gradients indicate a uniform degree of depletion or a high degree of fluid intercommunication between the various parts of the field either through the medium of an overlying gas cap or the pay itself. Closely spaced pressure contours and high pressure gradients reflect large variations in the extent of local depletion, or indicate poor fluid intercommunication and the persistence of interlease migration tendencies. Erratic and irregular pressure contours will result either from a haphazard fluid withdrawal pattern over the field, or a marked lenticularity in the producing section. On the other hand, systematic trends of increasing pressures toward the boundaries of a field are indicative of the presence of undepleted energy sources at these boundaries, either in the form of additional oil reserves or mobile edgewater drives. Conversely, systematic trends of decreasing pressures toward the field boundaries correspond to the pinching out of the producing section, or to a failure of surrounding edgewaters to exert an effective drive on the reservoir.

EDITOR'S NOTE: This article will be continued in an early issue of *The Petroleum Engineer.*

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Dr. Waldo L. Semon with test tires of synthetic and natural rubber. Immersed in oil at high temperatures for two weeks, the diameter of the natural rubber tire increased 40 per cent. Tire in foreground is size of samples before immersion

PETROLEUM ENGINEER Exclusive

by

C. C. Pryor

Associate Editor

☆ New type of synthetic processed by using technique similar to and equipment same as that for crude natural rubber

Ameripol—Synthetic Rubber Developed by U. S. Scientists

ONE of the largest plants in the United States engaged in the commercial manufacture of butadiene type synthetic rubbers is operated by the Hycar Chemical Company, a firm jointly owned by Phillips Petroleum Company and The B. F. Goodrich Company. The plant was originally designed and constructed by Goodrich to operate under patents and techniques developed by that company. The plant is operating approximately at its full capacity at the present time.

Dr. Waldo L. Semon, manager of Goodrich's synthetic research division, and discoverer of Ameripol, first experimented with the manufacture of dienes and their polymerization to produce synthetic rubber in 1926. It has been under the direction of Semon that the development and manufacture of Ameripol and other butadiene synthetic rubbers by B. F. Goodrich have been brought to a commercial basis.

The first pilot plant by the company was completed in 1939 with a capacity of 100 lb. of synthetic rubber per day. By 1940 two distinct types of butadiene copolymer synthetic rubber had been fully developed by the company. The first of the rubbers was a tire rubber and the second an oil-resistant specialty rubber, neither of which infringed on the German Buna rubber patents. Each of two synthetics has been marketed under the trade name Ameripol, signifying the American polymer. A commercial synthetic rubber plant was constructed with a capacity of about 2000 long tons per year to manufacture both types of the synthetic rubbers developed by the company.

The butadienes used in the manufacture of Ameripol rubbers may be derived from many natural-occurring hydrocarbons by a number of different processes. Among these are processes utilizing natural gas, crude oil, and grains.

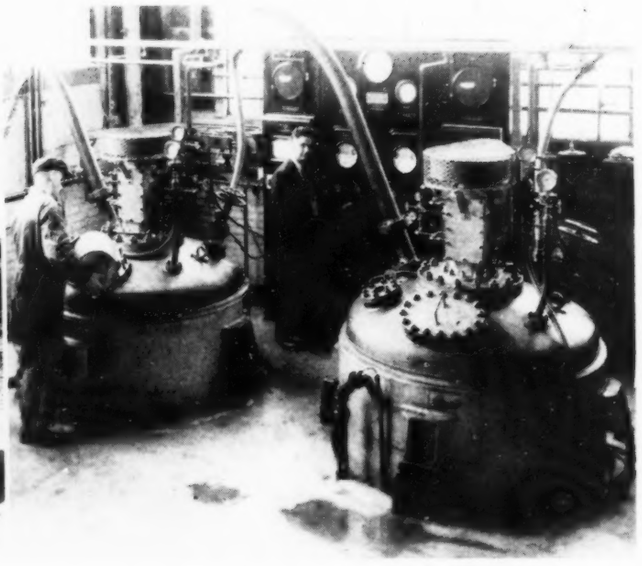
The butadiene molecules will readily polymerize with themselves or copolymerize with other substances, which also may be produced from abundant natural sources, mainly in the petroleum field, to form the long chain molecules that are necessary to produce commercial synthetic rubber. When the butadiene is emulsified under pressure with soap and water, polymerization proceeds very rapidly. This polymerization of the butadiene results in a milky suspension, which is quite similar to natural latex as it comes from the rubber tree.

Coagulated with acid in much the same manner as natural latex, the synthetic is sheeted and thus is produced the synthetic crude rubber.

Compounding and Vulcanizing

The same equipment and almost identically the same technique is employed in compounding and vulcanizing the Ameripol rubber as is used for natural crude rubber. The stocks of Ameripol can be worked with standard rubber machinery. They may be tubed, calendered, frictioned, spread, molded, and vulcanized by any standard rubber procedures. In general, the effects of carbon blacks, sulphur, accelerators, softeners, zinc oxide, age resisters, and other pigments on Ameripol rubber are the same as for natural rubber. Less sulphur and more accelerator are ordinarily required for Ameripol than for natural rubber compounds. Larger quantities of softener may be used, which usually aids in the processing of the synthetic.

Butadiene is stored in these tanks in a liquefied form under pressure. Butadiene is principal ingredient of Ameripol



Butadiene and other ingredients of Ameripol are polymerized in these pressure vessels

Physical Properties

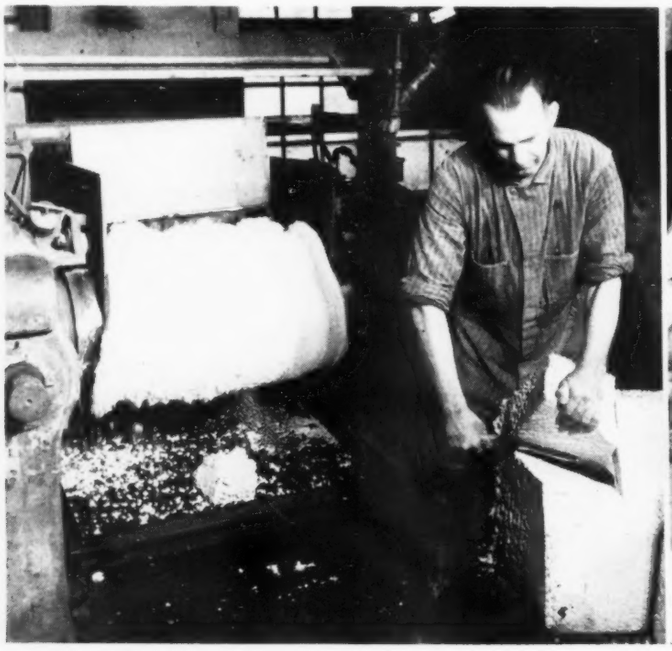
The physical properties of Ameripol rubbers are in general superior to those of natural rubber. Most important among these physical properties of Ameripol are its tensile strength and elongation. Due to the fact that the Ameripol rubbers are compounded differently for each of a large number of special uses, the strength and elasticity of the compounds vary over a wide range. Compounds having tensile strengths greater than 4000 lb. per sq. in. and elongations of more than 600 percent are, however, easily manufactured.

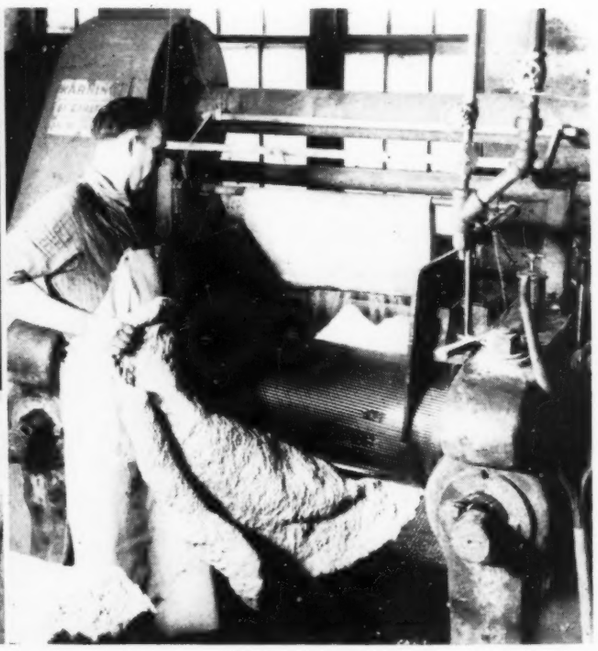
The resistance of certain Ameripol compounds to swelling or deterioration in the presence of mineral oil, gasoline, vegetable oils, fats, paint, and ink driers is another of this synthetic rubber's outstanding characteristics and has adapted its use to a wide variety of applications.

Under ordinary abrasive conditions, Ameripol tire tread compound has been found to be slightly superior, in abrasive resistance, to natural rubber compounds. Ameripol tire treads become far superior to natural rubber treads under high temperatures and in the presence of oils as they maintain in a higher degree their high abrasive resistance under these conditions than do natural rubber treads. It also has a minimum tendency to creep after the immediate permanent set is taken from applied loads.

Natural rubber oxidizes relatively soon after being made into products and decomposes when exposed to heat, how-

Blocks of raw Ameripol weighing about 110 lb. are cut up and sheeted on a wash mill. Ameripol is readily processed and handled on standard rubber processing equipment





Tires such as this have been made with content of from 50 to 100 percent Ameripol and had same standards of quality and service as natural rubber

ever, Ameripol rubbers display excellent resistance to oxidation and decomposition when exposed to heat. They can be firmly bonded to metals by the use of special cements.

The gas diffusion properties of Ameripol are better than those of natural rubber as it is less permeable than natural rubber.

General

The superior properties of Ameripol have caused products manufactured from this synthetic to be used commercially in many places where full advantage may be taken of these properties. Oil-resistant products now in most common use include gasoline hose and nozzles, oil hose, oil-resisting belts, gaskets for all types of machinery, automobile parts, airplane parts, sealing rings, valve cups for pumps, bullet-proof gasoline tanks, printing rollers, blankets, plates, and cots for textile spinning.

Its heat-resisting qualities are evidenced by its use for superheat packing for steam valves, packing joints, and certain automobile parts. Coated balloon fabrics and gas meter diaphragms take full advantage of the low gas diffusion characteristics of this synthetic.

John L. Collyer, president of The B. F. Goodrich Company, in his presentation before a Senate investigating committee stated that the synthetic rubber from which Ameripol tires have been produced cost about 60 cents per lb., however, Collyer stated that he believed that in plants having a capacity of 36,000 tons per year, synthetic rubber for tires could be produced for as low as 25 cents per lb. including amortization of the plants.

Photographs and material for this article were supplied by The B. F. Goodrich Company, Akron, Ohio.

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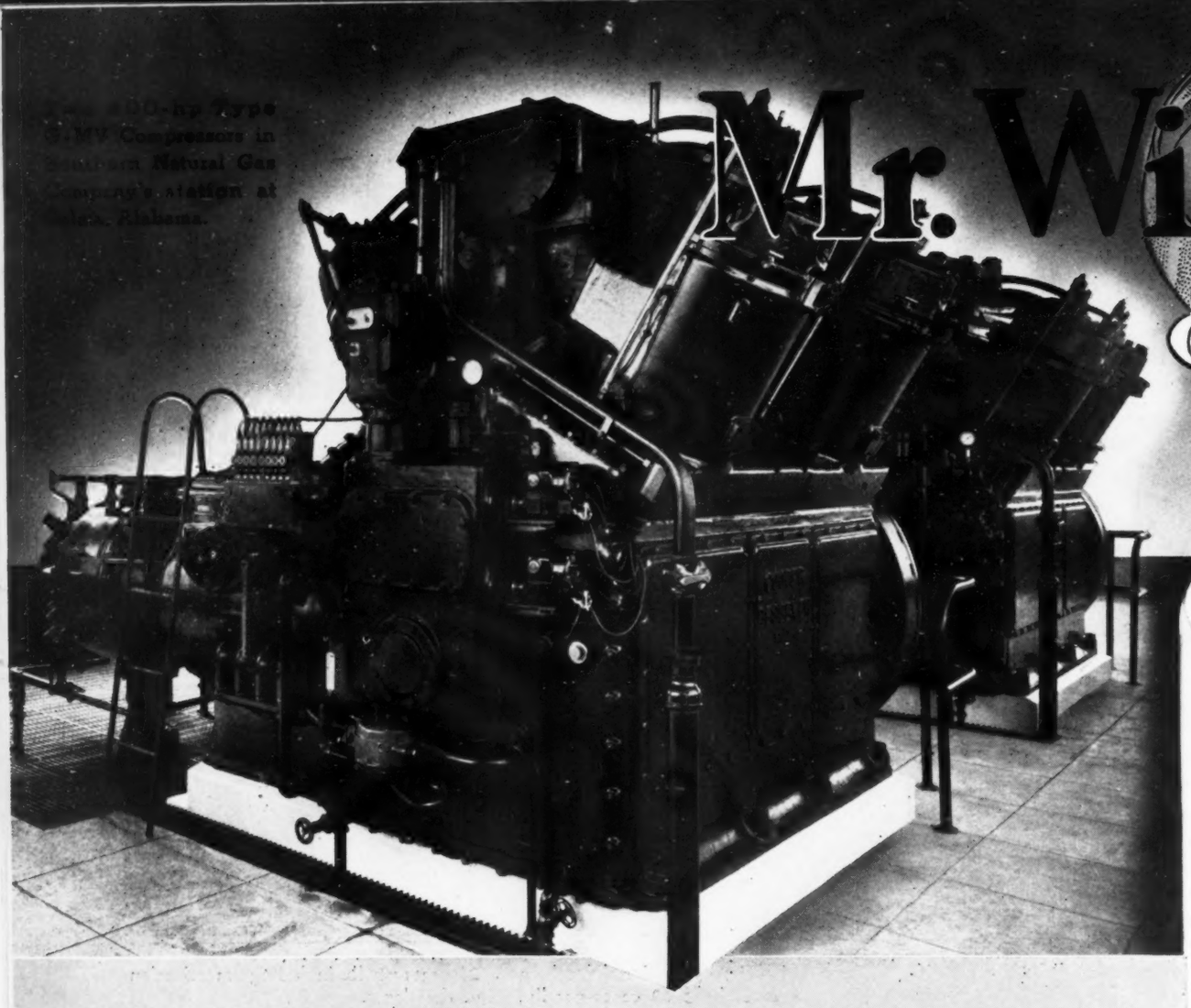
Principal ingredients of Ameripol are derived from petroleum, natural gas, and air. Research chemist in laboratory purifies one of ingredients by distillation

Material from polymerizers is thick, milky fluid similar to natural latex from rubber tree. Synthetic latex is stabilized by stirring for resistance to heat and oxygen



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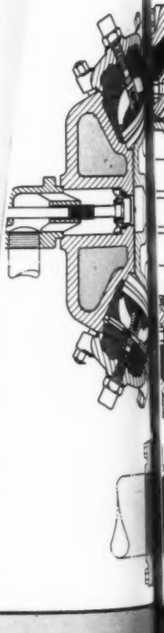

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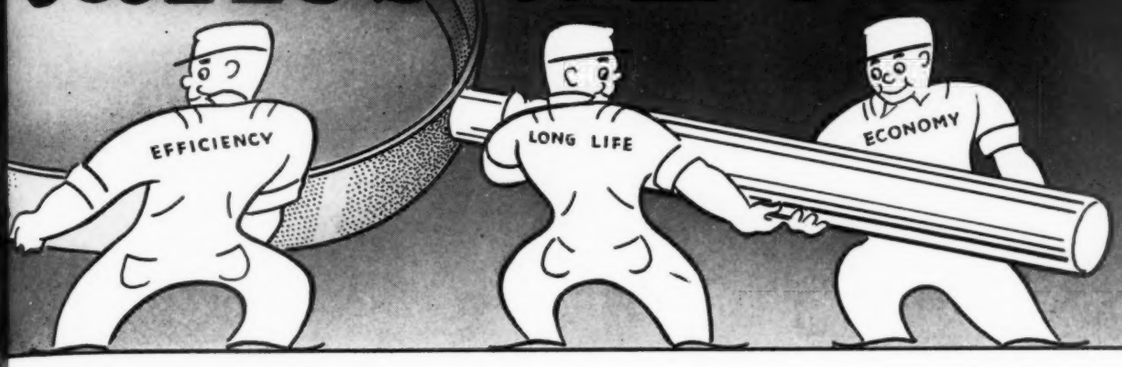

CROSS SECTION
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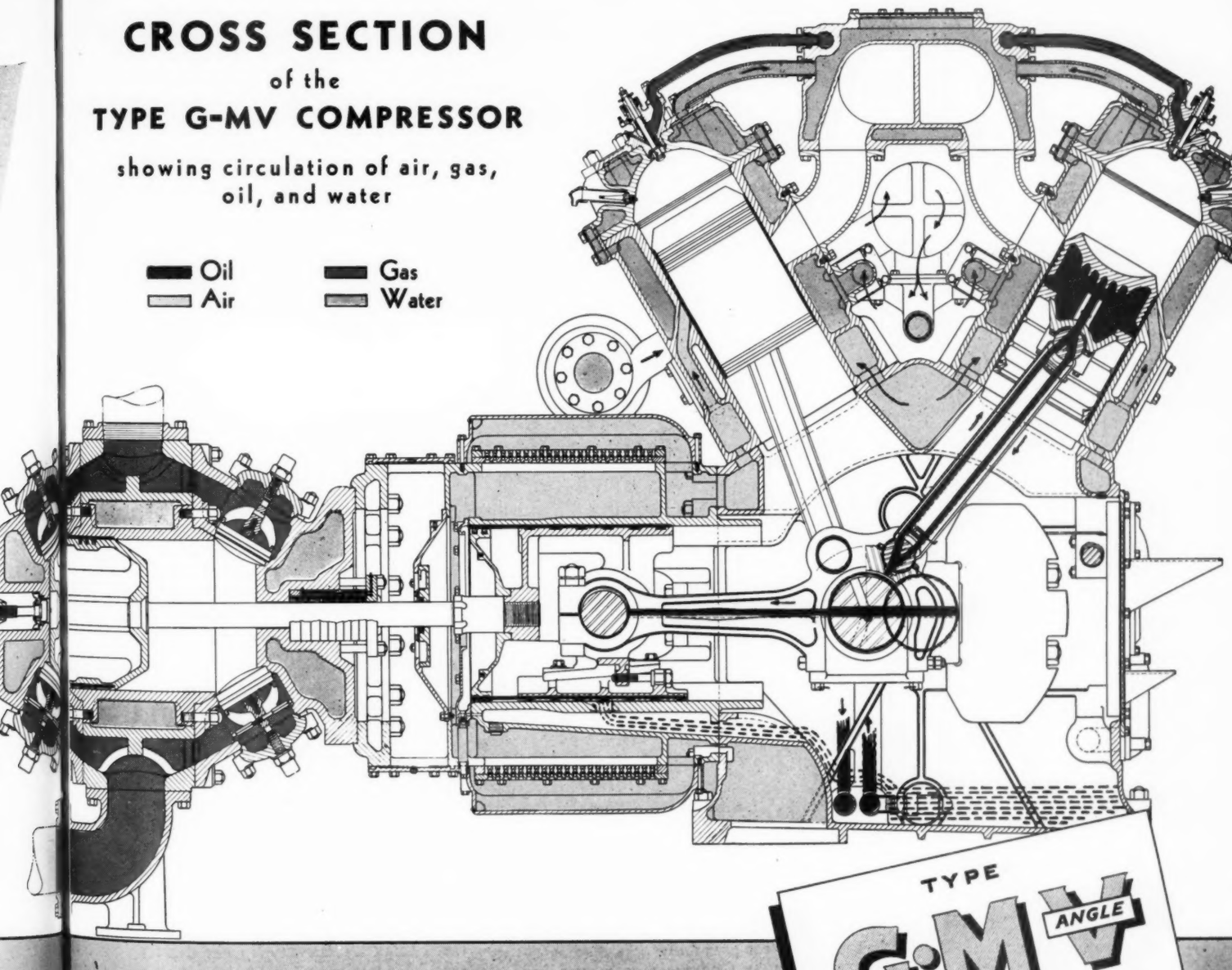
showing circulation of air, gas, oil, and water

Oil
Air
Gas
Water



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Class Meeting No. 2

(Continued)

NOTE: Throughout the class proceedings, no attempt is made to distinguish the identity of the pupil speaking. When a series of remarks is made by pupils it usually denotes an interchange of discussion among the class members themselves.

Leader: Going back into history just a little, there is another way of removing wax, that of cold settling it out. It might have some significance some time and we might at least mention it. We will have some heat at the bottom to be sure everything is mixed well and it will be a mixture of 75 percent naphtha and 25 percent oil. Where would you put your refrigerating coils? In the bottom or middle?

Pupil: At the top.

Leader: All right. Put the refrigerating coils at the top and begin bringing the mixture down. After the temperature of the mixture is reduced to zero or some such temperature, the settled oil and petroleum distillate and lube oil distillate are withdrawn separately and processed. So that process was a very definite step. The original method was to put the oil in tanks and let winter chill it; in the summer no lube oil was made. Then, of course, the coil was introduced and lube oil was made in summer and winter, and then because yields were poor the method was discontinued.

At that time bright stock was worth 25 cents a gal. and cost 25 or 28 cents to make it. Petrolatum was not worth very much—2½ or 3 cents per gal. Thus a product that gave such a poor yield fell by the wayside.

Pupil: I have never heard of any work being done regarding the taking of cold settled oil further down the line and further decreasing the pour point by other processes.

Leader: I never did either. I assume that it could be done.

Pupil: I wonder, except by solvent treating.

Leader: In this process, it is very evident that the paraffin must be amorphous, whereas when centrifuges are used it doesn't matter so much. You can find some crystalline wax with the centrifuge but by the chilling method you can't.

Pupil: Would you say that the small amount of wax crystals was not detrimental to centrifuge operations? I was thinking that this system would tend more to promote the formation of crystalline growth and from there on it might be the wax crystals would be more easily separated by pressing to give a better wax free oil.

Pupil: Would you find any particular difficulty with small amounts of crystalline wax in the centrifuge?

Pupil: I would say that the only difficulty is that it would tend to plug the centrifuge machine because the wax cannot be washed off.

Leader: We examined petrolatum microscopically and there was considerable crystalline wax there.

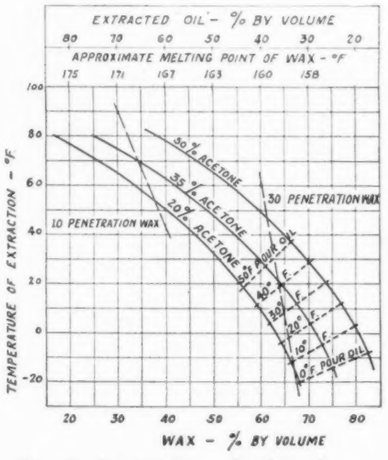

Fig. 2. Separation of oil and wax from Mid-Continent petroleum by benzol-acetone mixtures

Pupil: Time in crystalline growth means a lot.

Pupil: I am wondering whether the age of distillates has anything to do with the pressability.

Pupil: One major company has a program of storing wax distillate several weeks before it is run and I remember, later, after following their procedure, we discovered that there was some wax made that settled to the bottom of the tank and speeded-up pressing operations and seemed to improve wax removal by so doing. In our own case we did not find that to be so. So far as separating them, I would not think it made much difference whether it was 2 or 3 days or a month.

Leader: I believe fractionation had something to do with these decisions. I can see no reason why, by taking a well-fractionated wax distillate, you could not get crystals like this. That work was done on several wax distillates.

Pupil: Getting back to the crystalline growth of wax in bright stock, it would seem that by blending bright stock naphtha and applying heat there would be some wax dissolved in the naphtha that would in turn crystallize either in the naphtha or be left in the bright stock.

Leader: I think it would be interesting to compare our rate of chilling with the data given on page 36 of our text. It points out that dilution is undesirable because it requires additional distillation for removing naphtha from the dewaxed oil and the wax; also because the differential between the chilling temperature and the pour test of the product must be higher, as some wax is soluble in naphtha for dilution. The rate of chilling down to about 10°F. above the cloud test is apparently of no importance, but further chilling is carefully controlled and is usually about 1-2°F. or, as a maximum 3-5°F. per hour, until the temperature of the oil reaches 0°F.

Pupil: Kalichevsky was right about the effect of naphtha.

Pupil: It is not necessary to go to a lower temperature.

Leader: Yes, it is necessary, due to the solubility of the wax in the naphtha. I think Kalichevsky is right about that. He mentions 40 to 50 percent by volume. This matter of naphtha blending has so many advantages and disadvantages that I don't believe we should

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try to settle the matter now. Everything he says is right, but it can be supplemented by calling attention to these other points. The filter rate for instance—that can be increased very definitely by using a naphtha.

Pupil: Was the amount of wax soluble in naphtha ever determined?

Leader: Yes. There are some definite values given in the text. How about centrifuging? What is your opinion of pre-treatment before centrifuging bright stock solution? Do you think vacuum distillation changes that?

Pupil: I understand that some refiners did get into considerable trouble by not pre-treating.

Pupil: The control you have on your centrifuge is that you have an opportunity to look at the oil, and in the untreated dark oil you can't see the cloud.

Pupil: That is worth considering.

Pupil: That was one reason advanced in discussion of the light treat sometimes used. They are afraid they will not be able to get the pour point because the cloud is very difficult to see.

Pupil: We had a blend of bottoms and overhead on a certain crude that was so dark it was not possible to tell when the centrifuges were operating satisfactorily, resulting in high pour point oil.

Pupil: One company does just the opposite; centrifuges before treating.

Pupil: One objection to not treating before centrifuging is that a considerable volume of oil goes through the centrifuges that would not otherwise.

Pupil: I hesitate to bring up the subject of inhibitors again, but it would fit in nicely here.

Pupil: You can make a good pour point oil on a fairly non-refined oil, and then when it is refined, the pour point goes up on neutrals. It does the same thing on bright stock.

Leader: Yes, it still goes up. What are some of the disadvantages of this conventional dewaxing? Here is one of them. You always have to have a distillation before dewaxing in order to separate the types of wax. What do you think is the relative temperature differential? Is it more or less with solvent?

Pupil: Less with solvent.

Leader: What about costs? How about mechanical equipment, valves, materials? How often have you seen a piece of steel break into pieces when it is dropped?

Here are three disadvantages of conventional dewaxing:

(1) Distillation before dewaxing to separate types of wax.

(2) Temperature differential between oil pour and processing.

(3) Yields, lack of sharp separation between wax and oil.

Pupil: How about loss in dewaxing—oil loss? Is it less with the solvent?

Leader: I would say that the advantage is in favor of solvent due to lack of sharp separation between wax and oil. It seems we are making a case for solvent-treated oil. The only filter I have worked with was one used in removing some of the solids from fuel oil in which a pre-treated oil cake was built up and a vacuum applied to the under side and the oil pulled through the filter. Another method is to mix some of these various materials with the oil and press it out through some sort of filter press. What does the filter aid do and what do you consider the benefit of the filter aid?

Pupil: You filter to keep the material from going through at the beginning and then build up.

Leader: How about having the nucleus to build on?

Pupil: Formation of larger crystals.

Leader: I have often considered that there is a sort of filter aid provided by Foots Oil when it is blended into an ordinary wax distillate. Take a mixture of wax crystals about this size and then take a re-cracked Foots Oil that will have crystals very little larger, and by adding the two the crystalline group gets larger, entirely out of proportion to what they were before in either case.

Pupil: Wouldn't that be possible because some inhibitors increase the size of the crystals?

Leader: I have never found inhibitors that I thought increased the size; they are more likely to give you needles.

Pupil: You can add a dilution factor to dilute the amount of inhibitors present that decrease the size. You might form something in the re-cracking of the Foots Oil that tends to decrease the size of the crystals there, but when blended with the low wax distillate the two types of inhibitors tend to neutralize each other, allowing larger crystals to be formed.

Class Meeting No. 3

Leader: There are two general types of solvent dewaxing. Assuming we are discussing that of solids and the liquid variety, is viscosity of importance? Is it desirable to obtain a product as thin as possible?

Pupil: No.

Leader: All right. What about the differential in gravity or weight? Do we want the solution to be somewhat lighter than the wax? Is there any limit to that factor? How thick should it be; on the order of sorghum molasses consistency or thin like penetrating oil?

Pupil: Fairly thin.

Leader: If you were using a centrifuge, would you care to handle a thick material? Can you conceive of any influence it would have on viscosity other than the time factor? Would the centrifuge have to be redesigned if the material were thicker?

Pupil: Do you mean the solution as a whole or the solvent employed?

Leader: The solution as a whole. We must chill this for the wax to become a solid. After chilling, we want the solution to remain thin, don't we?

Pupil: To a certain extent, but not so thin that it might dissolve the wax.

Leader: A thin solvent with a noticeable weight differential between the solvent and the wax is required in the chilling process to produce solvent wax, and a solvent that will not dissolve too much of the wax should be used. Why?

Pupil: The solvent comes off with the oil and in the process of removing the solvent from the oil wax that has been dissolved in the solvent would be left in the oil. This could be reflected in a high pour point or a noticeable cloud in the finished oil.

Pupil: Water solubility is an important factor. The ability of the solvent to dissolve water should be considered if it is undesirable for too much water to be taken up in the process.

Leader: That is important in the recovery process; it is a definite factor. If we take these general viewpoints and then pass over to a more definite description, I believe we can bring these points out more clearly. We will write them down:

Solvent liquid essentials

Thin
Weight differential
Chilling
Wax dissolvent
Insoluble in solvent
Boiling point of solvent

Properties of good solvent

Miscibility of oil at operating temperature
Recoverable from oil and wax components
Easily separated from water
Produces wax to be removed mechanically
No chemical action on oil or wax
Design considerations—pressure and corrosion
Safety factors
Desired selectivity
Low cost—economical operation

Leader: What does the class think of miscibility? The solvent should be miscible in the oil but should not be in wax; we shall say miscibility in oil at operating temperature. The boiling point range must be such that it is recoverable; what should the boiling point be?

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TABLE 2
Properties of commercial solvents

Solvent	Boiling point, °F.	Solubilities at 100 °F.		Constant boiling mixture, boiling point, °F.	Composition constant boiling mixture overhead wt. % solvent
		Solvent in water, wt. %	Water in solvent, wt. %		
Acetone	133	∞	∞	none	none
Aniline	364	3.8	5.6	209	23.1
Benzol	176	0.16	0.11	none	none
Carbon tetrachloride	170	0.09	0.01	none	none
Chlorex	353	1.2	1.1	204-207	....
o-Cresol	375	3.0	14.5	210	6
m-Cresol	396	2.5	14.5	210	6
p-Cresol	396	2.2	16.5	210	6
Ethylene dichloride	182	0.9	....	158	91.8
Furfural	323	9.0	6.5	208	35
Methyl ethyl ketone	175	19.0	10.2	164	88.6
Nitrobenzene	412	0.3	0.35	211	15.3 (14)
Phenol	358	9.4	32.5	210	9
Propane	—48	....	....	none	none
Sulphur dioxide	14	....	....	none	none
Toluol	231	0.05	....	none	none
Trichloroethylene	188	0.16	0.05	167	....

This table appears as Table 6 on page 49 of "Modern Methods of Refining Lubricating Oils," by Vladimir A. Kalichevsky.

Pupil: Not above 400°F.

Leader: As a generalization, a solvent should be recoverable in some manner. How about the wax? We probably want to recover that. What would it be good for mainly?

Pupil: It all depends on market conditions. Some refineries have a sale for petrolatum, which would be produced under some phases of operation, whereas other phases would produce commercial micro-crystalline wax.

Leader: We are discussing normal scale operations—that of normal crude scale wax. How about chemical action? Is it desirable to have chemical action?

Pupil: No.

Leader: We are working for physical relationship. I suppose it goes without saying that in the process you want something that will give no undue concern.

Pupil: How about selectivity?

Leader: That is important. We should also consider the safety factor.

Pupil: Cost of your stock should be mentioned also.

Leader: We can say "economical operation".

Pupil: Loss would be included in the cost, wouldn't it?

Leader: I think it would. Investment and losses, etc.

What disadvantages have methyl-ethyl ketone and acetone? Sometimes these single solvents have a characteristic that is good but not good enough, so by blending two solvents the good qualities of both are enhanced to the extent that the total result is exceptionally satisfactory. There is an example discussed on the bottom of page 46 of the text.*

*"Modern Methods of Refining Lubricating Oils," by Vladimir A. Kalichevsky.

The dewaxing solvents mentioned (acetone methyl-ethyl ketone) dissolve practically no wax, at the same time they do not dissolve any appreciable quantities of oil so perhaps they are not very good solvents, but when combined with one of the coal tar derivatives they become very excellent solvents and dissolve large quantities of oil. Taking advantage of that fact has produced some excellent commercial processes. The chart on page 47 (Fig. 2) I think is worth studying. It shows the possibilities of increasing the oil yield by varying the amount of solvents used. Petrolatum is used in order to exaggerate the trend. As an example, if you propose to make 10 pour point, first using 20 percent acetone and then 50 percent acetone, the following results are obtained:

Using 20% acetone = 67% wax — 159 m.p.

Using 50% acetone = 79½% wax — 156 m.p.

The yield is 67 percent wax and 33 percent oil when 20 percent acetone is used. If 50 percent acetone is used, the yield is 79½% percent wax. The melting point in the first instance is 159 and in the second instance is 156. That will give you some idea of the degree to which oil yield can be increased by varying the quantity of the solvent.

Regarding water in solvents, notice Table 2, taken from page 49 of the text. Here are shown solubilities of various products at different temperatures. In general, solvents can be divided into those that do and those that do not form constant boiling-point mixtures and when the solvent does form the constant boiling-point mixture, separation can be accomplished by fractional distillation. Another matter that is rather vital: if you were selecting solvent for commercial applications, you would have to decide whether you wanted a solvent that produced wax by centrifuging or by filtration. What kind of filters are in greatest use?

Pupil: The closed filter.

Leader: Closed filters and perhaps continuous ones.

Leader: Returning to our previous discussion, the author of the text comments that when 20 percent acetone is used the wax was not filterable, but when 35 percent or more acetone was used the wax was very satisfactory in this respect. So that again illustrates the importance of selecting the proper mixture of solvents. It also brings out that the deciding factor in how far to go with the addition of a solvent is the balancing of loss against filterability.

Leader: A warning should be sounded here about the difficulties that are encountered in some plant operations due to the presence of chlorine compounds; or compounds that contain formaldehyde, etc.

Pupil: The author discusses that question on page 51, as follows:

"The solvent must be, evidently, inert towards the oil or wax under the conditions employed in the dewaxing operations. Some solvents, particularly those containing chlorine or some unstable chemical radicals of the aldehyde or similar types, may introduce certain difficulties in plant operations. These difficulties are usually solved, however, by employing proper temperature ranges in distilling off the solvent under vacuum, etc., although they cannot be overlooked in choosing the dewaxing solvent for plant use."

EDITOR'S NOTE: This series will be continued in an early issue of *The Petroleum Engineer.*

☆ ☆ ☆

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STATIC electricity in belts can be avoided. When a belt in itself is a good conductor of electricity, there will be no static. Take, for example, rapidly revolving metal disks. Such disks never create static because they are first-class conductors of electricity. A belt made of steel or copper or any other ordinary metal will therefore never generate any static. This makes it plain that if you metallize a belt by stitching copper wires in it from end to end and from side to side, it need not be grounded; or, a belt that is treated in any way that will make it a conductor will not generate static, hence need not be grounded except for precautionary reasons.

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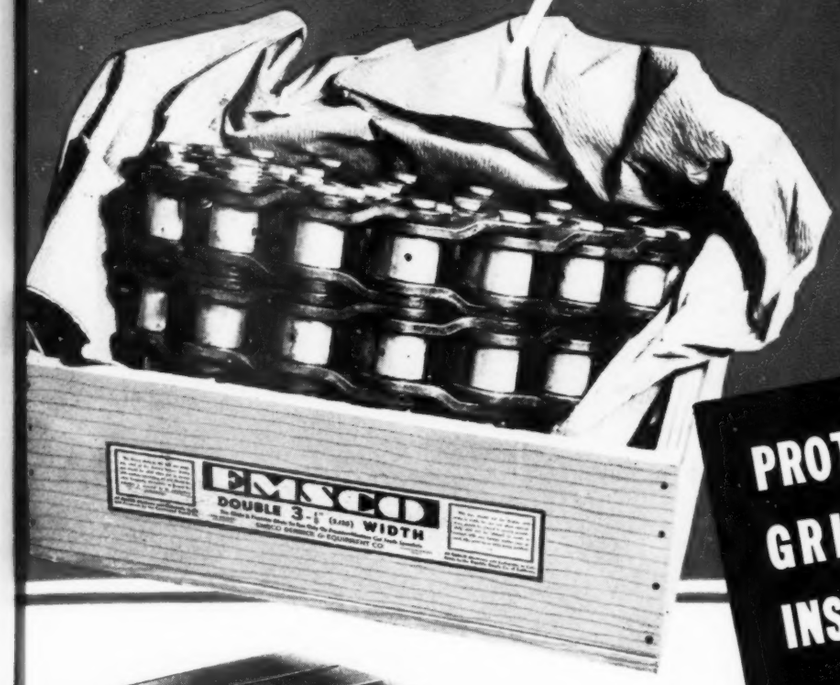

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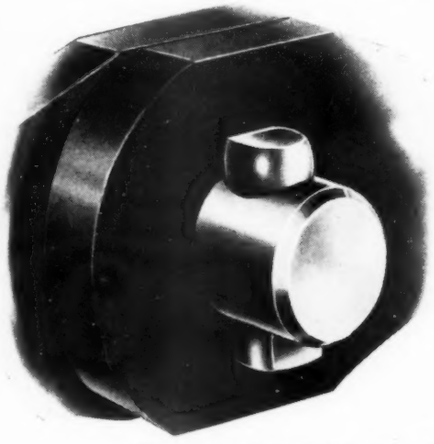

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Use of Explosive Cord for Cleaning Perforations

☆ **Well production increased by cleaning of perforations and annulus and formation behind the perforations**

by Wallace A. Sawdon
Pacific Coast and Foreign Editor

THE time has arrived when increased production must be obtained from many wells that, during a period of curtailment, obviously have not been maintained at maximum efficient production for economic reasons. There are perhaps thousands of wells throughout the country in which perforations are clogged to some extent with mud, rust, scale, wax, or other foreign matter and are thus not allowing a full flow of oil from the productive zone. This is particularly true of heavy oil wells; and in California, where the supply of heavy oil must be maintained, the cleaning of perforations, and the annulus and formations behind the perforations, has already aided in increasing the supply that is so greatly needed. Perforation cleaning is, of course, a maintenance operation but the better maintenance of all older wells is more completely realized under present conditions than at any time in the last few years.

Cleaning Perforations With Explosives

There are a number of methods that have long been successful in cleaning perforations. Some of these methods are more adaptable than others under certain conditions and most operators are familiar with the various procedures being followed. The use of an explosive for this purpose, however, was introduced in California a little more than a year ago and has provided a quick means of cleaning both slotted and round hole perforations. The method is, moreover, adaptable to cleaning one or more zones with one run of the equipment. The cleaning service* has recently been made available in other territories. In the Gulf Coast area it has been used to clean screen liner as well as perforated pipe.

*Selective well-cleaning service is provided by Lane-Wells Company.

The explosive applied to well-cleaning operations is provided in the form of a cord and is run into the well on a conductor cable. The cord extends through the zone to be cleaned and is detonated from the surface by electrical current. Best results are obtained when the explosive is in fluid, as the fluid facilitates the transmission of pressure that cleans the openings. The kind of fluid or the static head does not matter. The cord has been used in wells having temperatures as high as 275° F.

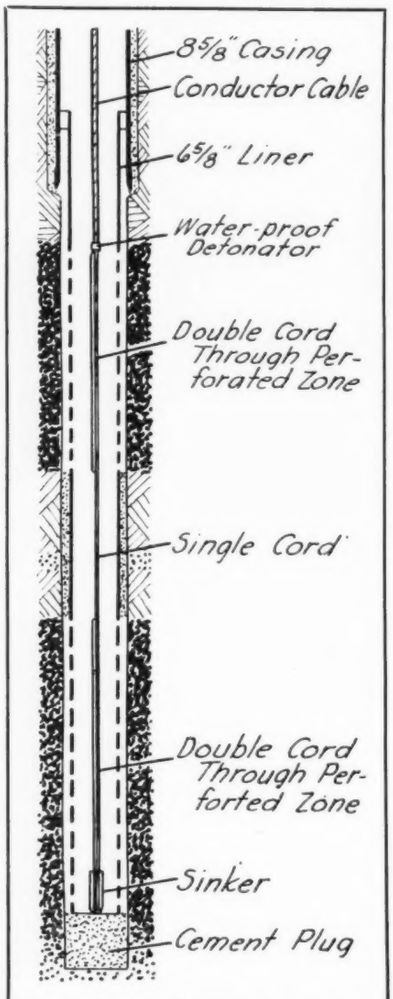

Fig. 1. A typical two-zone arrangement for cleaning perforations with explosive cord

Although the explosive cord has the appearance of a slow-burning fuse, it explodes at a high rate of speed, the speed of detonation being more than four miles per second. The amount of explosive per lineal foot of cord, however, is very small and is not sufficient to damage casing or liner. The cord is relatively safe to handle as it requires considerable shock to begin detonation.

The cleaning action of the explosive method of well cleaning depends on the pressure induced by the explosion. As the full pressure must be applied to make it effective, the cleaning value is derived from the speed of detonation because any open perforation to which pressure is applied in the usual manner will permit fluid to flow through it and relieve the pressure on the clogged perforations. Due to the great speed of detonation, fluid cannot pass through an open perforation fast enough to relieve the pressure on the clogged or partially clogged perforations and the pressure is thus applied to all parts of the liner opposite the cord, to all perforations whether open, partially clogged, or closed.

When there is no tubing in the well a 2-in. diameter sinker 5 ft. long is attached to the end of the cord. This sinker consists of a shell usually filled with sand. The bottom of the cord is attached to the bottom of the sinker so that the sinker is a part of the explosive element and does not have to extend below the bottom perforation. Detonation

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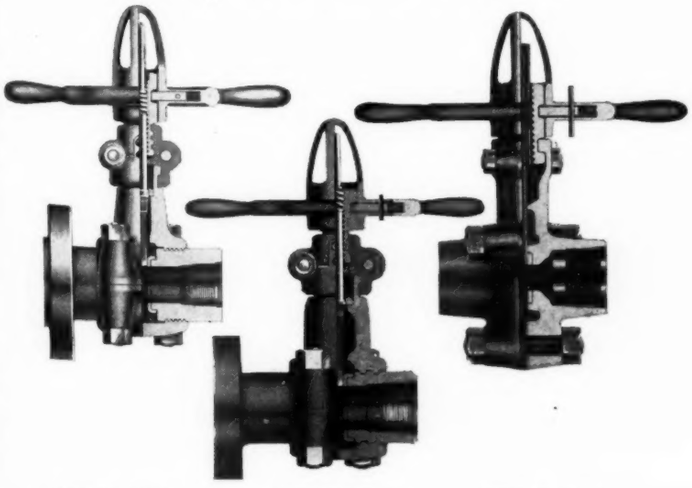

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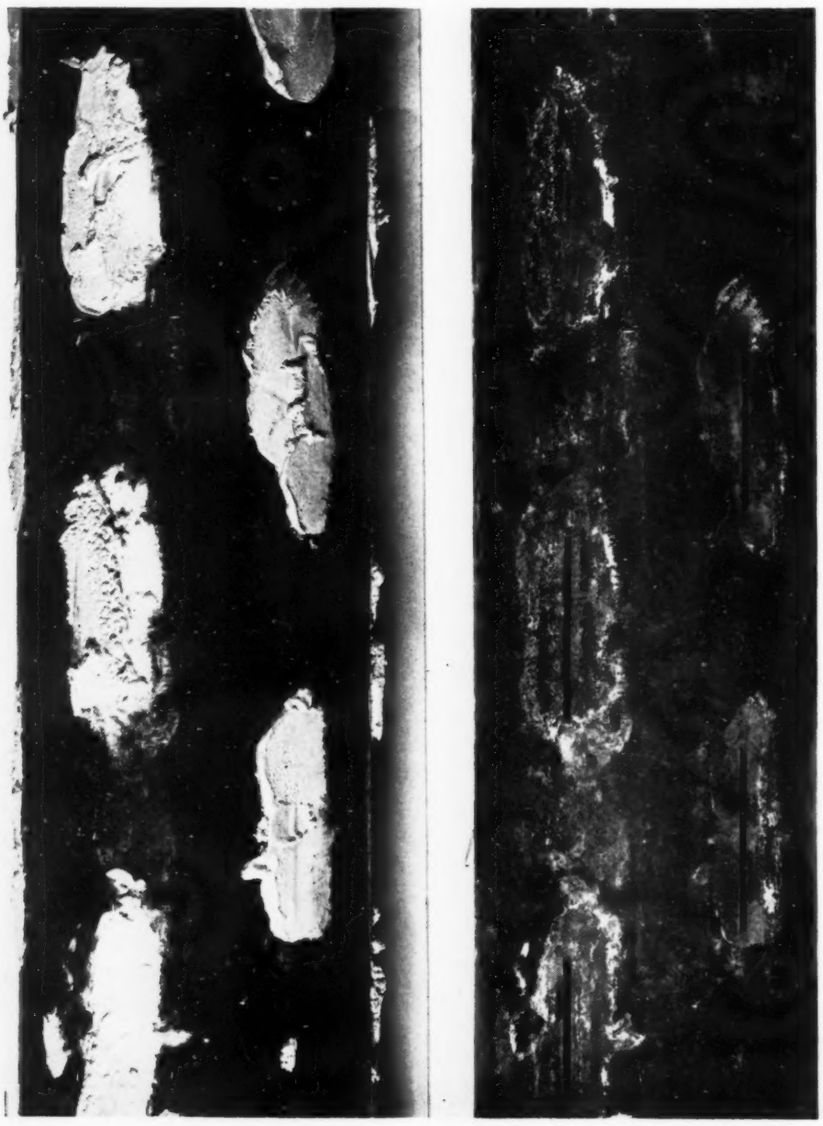
begins from the top of the cord but is so fast that the sinker does not have time to fall appreciably before it is exploded.

If the explosive cord is to be run through tubing and extend below the bottom of the tubing string, the sinker is made 10 ft. in length and has a diameter of 1 in. When the tubing is set below the top perforations it is frequently raised to a point above the perforations so that all openings may be cleaned. After the cleaning is completed the tubing can then be set at the desired level.

Using More Than One Cord

Additional power for cleaning perforations is obtained by paralleling two or more cords when needed. In most of the work done to date two cords have been used through the perforated zone and with these adequate cleaning action has been obtained in the average 6⅝ in. to 8⅝ in. sizes of pipe. For particularly tough jobs three or four cords have been used in parallel but ordinarily more than two cords are required only when the formation is unusually tight against the casing or liner. Under such conditions the formation provides support to the pipe and prevents damage from the more powerful pressure induced by the explosion. One cord is generally used for small diameter and thin liners but two cords may be employed if such liners are in good condition and are known to be supported on the outside by the formation. When sand trouble is likely, one cord is used regardless of the size and condition of the pipe.

Fig. 2. Many tests of the effectiveness of the explosive cord have been made aboveground. In the one shown here, slots in a section of liner were filled with a mixture of litharge and glycerin and allowed to stand a week to obtain an extremely hard clog of the slots as shown to the left. The slots were then cleaned with explosive cord with the result shown to the right



Cleaning Several Zones

When two or more perforated zones are to be cleaned by explosives a single cord is positioned from the bottom of the lowest zone to the top of the highest zone. In most cases an additional cord is necessary through one or more of the perforated zones so these additional cords are attached to the long single cord to lay opposite the perforated zones where they are needed to give the required power. (See Fig. 1.) The single cord through the blank sections of casing or liner does not affect the pipe.

From experience it has been found that it is not economical to clean more than one zone per run of the equipment when zones are much more than 100 ft. apart. The limit of cord length is approximately 500 ft. although under favorable conditions this length has been exceeded. The tensile strength of the cord is the limiting factor.

Operating Equipment

The operating equipment is carried on a light truck and consists mainly of a hoist on the drum of which is spooled 10,000 ft. or more of rubber covered steel cable. A weight indicator and measuring device are incorporated in automatic spooling equipment placed in front of the drum. Light-weight sheaves on the rig floor and in the derrick provide for fast and convenient rigging up.

The thickness of individual zones cleaned in California has ranged from a few feet to a little more than 100 ft. Increases in production obtained by cleaning naturally depend on down-hole conditions; if additional flow of oil is not in the sand, all the cleaning in the world will not increase production. In some of the thick zones cleaned by the explosive method, increases in production have been as great as several hundred percent and in one case production was increased from 30 bbl. per day to 130 bbl. per day. Among the commonplace examples was a well in which production was increased from 12 to 37 bbl. per day; another from 16 to 45 bbl. per day, and a third from 4 to 9 bbl. per day.

The cord explosive has also been used to aid in pulling liners. This is done by detonating the cord while a strain is held on the liner. The effect of the explosion has usually been sufficient to start the liner out. As drill pipe is used for such operations, the 1-in. diameter sinker is attached to the end of the cord.

☆ ☆ ☆

We Learned the HARD Way

ONLY a few years ago manufacturers of oil field equipment worked to tolerances designated by fractions of an inch. It was a big step forward when the term "thousandths" was generally adopted, but we did not really learn the full meaning of "plus or minus" until we were initiated into Government inspection.

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by J. R. Thomas

President, Richfield Consolidated Oil Company

REPAIRING and redrilling oil wells have never received proper recognition by the oil industry. Perhaps the flowing well with its headline characteristics and quick return of capital leads the operator to venture in quest of new horizons, forgetting or ignoring the possibilities of the very profitable reworking of his older properties. This phase of the oil business will no doubt receive a great deal more consideration now that government regulations have greatly restricted the drilling of new wells.

The writer contends, however, that repair work at all times offers a very lucrative return for small investment per unit. Over a period of 20 years, during which time the writer has been directly connected with the repairing of hundreds of wells, the average cost of production has been found to be approximately $120.00 per bbl. of daily production, which is less than half the cost basis on which the poorest grade producing property can be bought in the open market. The larger part of this work was done before well surveys, electrical logs, and other modern devices were available to assist the engineer. With these modern aids, repair work should be even more attractive from the standpoint of sound economics.

A few reminiscences will illustrate the queer mental gymnastics that govern the policies of some of our operating companies.

Company Policies

A job estimated to cost $12,000 and yield 150 bbl. per day of 70-cent oil was turned down because it would not pay out in three years. It would not pay out in three years because it would be curtailed to about 75 bbl. per day and lifting cost was estimated at 30 cents per bbl. regardless of the size of the well. Yet that company was spending millions annually in a glutted market trying to discover "reserves" but couldn't consider deferring capital return on present properties beyond a three-year period when a producing life of 20 years was conservatively indicated. Numerous operators would welcome the opportunity to contract the operation of average 75-bbl. wells for considerably less than the $675 per month figure used as a production cost. This company would not have hesitated to purchase this grade of settled production in the open market on the familiar basis of $300 per bbl., or for a purchase price of $45,000, yet it would not invest $12,000 on a virtual certainty of establishing an asset valued at $45,000 on its own property.

J. R. THOMAS

served in the first World War in the Signal Corps for two years—Was discharged June, 1919, and went to work in September, 1919, at Fellows, California, for the American Oilfields Company, a subsidiary of California Petroleum Corporation, as an engineer—Served as petroleum engineer for this company until February, 1931—Shortly thereafter was petroleum engineer for North American Oil Consolidated at Taft, California, until January 1, 1933, when he became superintendent of that company, leaving on January 1, 1940—Elected president of Richfield Consolidated Oil Company in August, 1940.

To cite another instance: a company drilled a well at a cost of $50,000 in a flush field, obtaining 1500 bbl. flush production. It was understood by the management that the flowing life would not be for more than three or four months and the total producing life not more than a few years. Yet the company was highly pleased with the well. This same company spent another $50,000 to redrill 5 idle wells to a "forgotten" sand and obtained 300 bbl. settled production with a producing life of 20 years. This second investment yielded a value several times the value of the flowing well, but the management's reaction was the opposite, as the cost had been charged to production, instead of development, and reflected on the management's reputation as an economical producer. Granted that $50,000 tacked onto the production cost in one year on a medium-sized production unit does increase the per-barrel lifting cost materially, granted that it is sound practice to charge such repair work to production from an accounting and tax standpoint, these considerations should not be allowed to outweigh the fact that a $150,000 asset was created at a cost of $50,000.

The writer's attitude has always been the exact opposite of that illustrated above. Any operator can sufficiently develop production in a flush field before the various intermediate waters have made their appearance, but it requires careful study and some ingenuity to rehabilitate old producing properties. The latter is, therefore, a greater engineering achievement that seldom receives due credit.

Many California oilfields offer promising opportunities for re-working. Numerous fields were developed before there were means for obtaining full knowledge of the characteristics of the formations penetrated. In some of these fields several zones were left open to production in the same well with water sands between. The wells originally produced clean oil but later the water from the intermediate sands made their presence known. The problem now faced is the proper isolation of the producing sands and the exclusion of water. In many cases upper sands capable of commercial production were cased-off behind the water string and may be successfully exploited either by re-drilling or by perforating the water string.

Electrical logging devices have now reached a stage of perfection where guesswork is largely eliminated in determining the nature of the various formations. Where sufficient open hole logs have been run, the "radio-activity" log inside cased holes may be successfully correlated.

PETROLEUM ENGINEER EDITION

BAASH ROSS News

BAASH-ROSS TOOL COMPANY, LOS ANGELES - HOUSTON - NEW YORK

A BULLETIN COVERING NEWS OF EQUIPMENT AND OPERATIONS IN THE PETROLEUM INDUSTRY

WHAT TO LOOK FOR IN DRILL COLLARS ...AND HOW TO BE SURE OF GETTING IT

Many Things Influence Drill Collar
All Must Be

ACCURA
MENT —
collars
misalign
causes
where collars
string rotates
bends—first
the other—
bending
pins. *But*
Ross Drill
survey *every*
sure that the
axis of the join
deviate from the
axis of the collar
than ½" in 40 fe

TOUGHNESS —
ing the bit, the Dri
lar is constantly subj
to severe impact an
sional strains as th
tational resistance o
bit fluctuates—high
minute, low the ne
Careful selection of al
steels plus two full len
heat-treatments and
third localized heat-trea
ment, insure the corre
amount of *toughness* i
every B-R Drill Collar.

HARDNESS—The Drill Collar, following as it does right behind the bit, is constantly rotating against the highly abrasive, fresh-cut walls of the hole where no protective mud-cake has been built up. In heat-treating "Trubore" Drill Collars, special precautions are taken to insure plenty of surface *hardness* to resist this abrasive action.

FOR MAXIMUM ALL-AROUND PERFORMANCE, IT'S BAASH-ROSS "TRUBORES"!

YOUR BAASH-ROSS DRILL COLLARS AND KELLYS HAVE A *Bigger* JOB NOW

Official U. S. Navy Photograph.

The same top-quality alloy steel that goes into the manufacture of your Baash-Ross "Trubore" Drill Collars and Kellys is today finding an even more important job in strengthening the sinews of America's armed might.

Next time you turn to the war news, think to yourself . . .

"Perhaps the drill collar I was unable to get this month went into making the very gun I see in action here.

". . . or it might have gone into making the armor-piercing noses of the bombs that sank the Jap aircraft carrier AKAGI off Midway.

". . . or it might now be a part of an Allied armored unit beating off the enemy in the hot sands of Egypt."

Fact is, we don't know exactly where the steel for that drill collar or kelly of yours is right now. But we do know this . . . wherever it is and whatever it's doing, it's doing the job in a man-sized way. Because Baash-Ross uses only top-quality alloy steels in making its drill collars and kellys—steel that is hard, tough and "hell-for-stout."

So by doing longer with your present drill collars and kellys, you are releasing more of this fine metal for the difficult two-fisted jobs our armed forces need done. And that is the most important work of all right now . . . building an army and a navy and a marine corps that are the best-equipped fighting units in the world!

...ORTANT FACTS ABOUT KELLYS!

...logical that the subject of ...s should bring up talk ...ther end of your drill ...elly end.

...hin you're getting the ...hate for your string of ...ll Collars be sure to ...Ross *"Trubore" Kellys* these Kellys go the ...ame painstaking pre- careful selection of ...ntrol of heat-treat- ...ade the "Trubore" ...rever men drill for

...Ross you can get ...lly you prefer...

...the old "stand- ...ral drilling con-

...AL—the best ... buy for all- ...g efficiency.

...—a popular ...ith packers ...under pres-

...can supply ... kelly you ...ask *us* for ...ch of the ...ern drill- ...*give you* ...*r dollar* ...we can

...by an

...om- ...he

...ION AREA - of vital im- ...ence with modern high-volume pumps.

...does not ... *in 40 feet*... ...ness does not deviate ...than ⅛" from true at any point *over the entire length*...and you have some idea of the *all around* balance that makes Baash-Ross "Trubores" the pick of the industry.

These things are hard to *see* in a drill collar, but there's an easy way to KNOW you are getting them—specify *Baash-Ross "Trubore Drill Collars!*

...but ... leg" ...ence in the flow of the ... fluid, setting up "eddy cur- ...ts" that eat out and enlarge the hole at this point—throwing the collar—and with it, the drill string—into

THEN REMEMBER THIS: You can use the hex for *every* type of drilling operation... BOTH regular and pressure work *—without change!*

Regardless of the *type* of kelly you plan to buy, there is a Baash-Ross "Trubore" to meet your requirements. But before you buy *any* kelly, investigate the Baash-Ross HEXAGONAL. Your nearest Baash-Ross representative has complete details...or write us direct!

Individual Operation

Idle and non-commercial wells that can be purchased at some figure slightly above actual salvage value usually turn out to be good investments. Careful selection of such wells is, of course, required. They offer a good opportunity for individuals with small capital to enter the oil business. Many substantial operators have made their advent into the business by this route. A number of supply men also have become oil producers, unwillingly at times, when poorly financed projects in which they had "lend-leased" equipment failed to materialize. Most idle wells should be purchased at prices ranging from $2500 to $7000, depending on the amount of salvage. Oftentimes an expenditure of $2000 will place the well on production. Even a 10-bbl. well with such a small investment will yield a fair income on the principal. If the venture fails, the loss is only slightly more than $2000. A well producing 25 bbl. or more becomes a profitable venture.

This type of operation by an individual as an operator has a number of attractions not common to other investments, not the least of which is the 27½ percent depletion allowance and rapid write-off in depreciation. Heavy corporation taxes are also avoided, allowing the individual to produce more cheaply than the corporation. A three to five year return of capital is usually expected and as most California fields have shown producing lives of better than 20 years, with some now producing in their 40th year, it appears that fears of early depletion have been over-emphasized in estimating the value of oil to be produced in the future.

Comparing returns per amount of capital involved with other types of investment such as stocks and bonds, real estate rentals, etc., a very definite advantage is shown in favor of oil investments.

For comparison assume a $10,000 investment in a sound stock that will yield 6 percent or $600 per year. Bonds will yield considerably less, and real estate rentals that net 10 percent are considered good. An investment of $10,000 in a 15-bbl. well at about $1.00 per bbl. oil should yield a net income of $2700 per year, barring unusual lifting difficulties, or a net of 27 percent with a substantial salvage backlog against total loss due to the hazards involved in all oil-field work. Money invested in a corporation also is taxed before the corporation can pay dividends and then again the dividends are subject to income tax without the benefit of earned income credits.

Conclusion

It is not meant to imply that reclamation work on idle wells is a get-rich-quick method requiring only some capital and a will to increase it. There are many unknowns involved in the purchase of an asset that someone else has conceded to be of no productive value. Many jobs will prove that the seller was right and the buyer was wrong. An experienced oil man with good engineering advice and sufficient capital to afford some losses, however, should succeed often enough to obtain substantial returns for his time and capital. The writer has just completed a 50-bbl. well at a total cost of $8000, so perhaps he feels unduly optimistic.

Neither is it meant to imply that the search for new fields should be discontinued. The point to be made is that old properties should be given more consideration as a possibility for future reserves. Extension should be made for the pay-out period when necessary to experiment and test the various possibilities of the property. Initial efforts in such tests are apt to prove unfruitful but are sometimes necessary to determine the proper steps to take for later more successful work.

The larger companies in search of reserves should re-examine the possibilities of their older properties. The reserves can be had at much less cost, with greater certainty and quicker return of capital.

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P 261.

Photomicroscopy of Salt In Petroleum

PHOTOMICROSCOPY — making pictures with a combination camera and microscope — has been employed successfully by U. S. Bureau of Mines chemists to identify and study the tiny brine droplets and salt crystals in crude petroleum that often interfere with the refining process, according to Dr. R. R. Sayers, director of the Bureau.

Chemical analysis heretofore has been the ordinary method of determining the physical form and behavior of the various salts in crude oil, but the Bureau's studies now make it possible actually to see the minute impurities that "constitute a major problem in the petroleum industry's refining operations."

Designed to supplement chemical analysis and to provide a visual record as an aid in simplifying the industry's refining problems, the new process is described in a technical paper recently published by the Bureau of Mines. The paper covers data relating to the physical state of salts in some of the Mid-Continent oils, and the investigation was made in coöperation with the State of Oklahoma.

"Crude petroleum contains impurities such as emulsified salt water and crystalline salt which often interfere in the refining process," the Bureau investigators commented in explaining the reason for the studies. "The emulsion appears as a mass of tiny droplets which are individually invisible to the naked eye. However, each droplet is surrounded by an oil film. Often the droplets contain microscopic crystals of salt."

With the aid of the petrographic microscope and camera, Bureau experts were able to prove that magnifications ranging from 100 to 500 diameters were necessary to see the natural shape, size, character, and behavior of the emulsion droplets and salt crystals in oil.

As a result of the studies, a number of facts pertinent to refining problems were discovered and described. For example, with the microscope it was possible to see the effect of emulsion-breaking chemicals and to watch crystals of salt form in the brine droplets. Furthermore, the observers were able to find salt crystals that were encased by wax and other gummy substances in petroleum, to identify the salt crystal by its optical and crystal properties, and to study the behavior of these crystals in the residual oils during refining.

All photomicroscopic work of the investigators was checked by chemical analysis, in order to verify the accuracy of the method and to add to the information revealed by the microscope.

Detailed descriptions of the microscopic phenomena, together with photomicrographs of droplets and crystals, are contained in Technical Paper No. 638, "Photomicroscopy of Salt in Petroleum," by Lloyd F. Christianson and J. W. Horne, which may be obtained from the Superintendent of Documents, Washington, D. C., for 25 cents.

☆ ☆ ☆

WORTH KNOWING... WORTH SHOWING!

Modern military strategy and tactics have placed a new emphasis on aviation, which in turn has led to rapid expansion of the United States Army Air Forces; with this have come new badges indicating the branch in which the wearer is a specialist, as well as distinguishing between the several grades of pilots.

In addition to those shown is the navigator's wings, similar to the combat observer but with the world inscribed within the circle.

Military Aeronauts of the Balloon Corps wear spread wings with a balloon and suspending basket superimposed in the center; this is replaced by a dirigible for the Lighter-than-Air Service.

HUGHES TOOL COMPANY
HOUSTON, TEXAS

Durability of Cements in Contact with Brines and Chemical Solutions

PETROLEUM ENGINEER Exclusive Feature

☆ Results given of tests made with 27 different cements

by H. H. Miller

Dowell Incorporated, Midland, Michigan

CEMENTING materials have been known since antiquity. The early Egyptians, Greeks, and Romans knew that certain volcanic deposits when finely ground, mixed with lime and water, produced a product having excellent strength and sea water resistance. Several centuries passed, however, before any advances were made in the manufacture of mortars. In 1756 John Smeaton discovered that limestone rich in clay, when burned and mixed with water, formed a mortar that would set firmly under water. It is generally conceded that Smeaton was the father of our present, modern cementing practices. The first patent on cement was granted in 1824 to Joseph Aspdin, a Yorkshire bricklayer, who heated finely pulverized chalk, or road dust from limestone roads with the clayey muds of the Midway River. He forced the burning temperature to higher levels and carefully controlled the grinding and mixing, which resulted in a cement similar to the Portland stone from which the term, "Portland Cement" originated.

Shortly after 1796 natural cement deposits were found at Rosendale and Louisville that attained great importance. This cement was used chiefly for work exposed to water. Portland cement companies have made rapid strides toward perfecting the product by improvements in kilns, mechanical appliances, and the improved knowledge of the composition of the product.

Chemical Composition

Portland cement is composed of a number of chemical compounds that react with water to form hydrates. The principal compounds in Portland cement involved in this hydration are tricalcium silicate ($3CaO.SiO_2$), dicalcium silicate ($2CaO.SiO_2$), tricalcium aluminate ($3CaO.Al_2O_3$), tetracalcium alumino-ferrite ($4CaO.Al_2O_3.Fe_2O_3$), and calcium ferrite ($2CaO.Fe_2O_3$).

The principal strength-contributing compounds are the tricalcium and dicalcium silicates. The rate at which cement hydrates depends primarily on the relative portions of tricalcium aluminate, tricalcium silicate, and dicalcium silicate, and the degree of fineness of the cement particles.

H. H. MILLER

is a native of West Virginia—Attended Littleton high school and Wesleyan College there—Had four years' teaching experience and was associated with oil-well development for two years—Has been with The Dow Chemical Company since 1929, where he did analytical and research work for 10 years—Now heads the Dowflake Road Research Division.

Tricalcium silicate not only contributes much of the early strength, but also is effective in increasing the strength at later ages. Dicalcium is largely responsible for increase in strength beyond the 28-day period. Tricalcium aluminate contributes strength to an important degree up to 28 days, but its effect then diminishes slowly to zero. The tricalcium aluminate is also very susceptible to attack by ground water or brines, which are often encountered in oil wells. The sulphate of the brine will react with the alumina, forming a hexahydrate crystal with a large increase in volume, resulting in an explosive effect. Cracks are formed and the attacking solution penetrates still deeper, repeating the process.

The object of the present investigation has been to determine the durability of various types of cements, and admixtures of cement and other materials, when in contact with certain typical oil-field brines and when in contact with certain chemical solutions. Oil-field brines from Michigan, Texas, Illinois, and Kansas were used in certain durability tests, and in other tests 6 percent solutions of sodium sulphate, sodium sulphite, magnesium sulphate, magnesium chloride, sodium chloride, and calcium chloride were used.

Reference to Figs. 1, 2, 3, and 4 will show that most of the cement specimens did not stand up well on the 90-day durability test and that they were markedly attacked or disintegrated by the natural or artificial brine. The cements that stood up best in all the brines were acid-soluble cement, lumnite cement, and Portland cement containing fly ash.

Procedure

A total of 27 different cements was obtained in bag lots from various companies that supply cement to the oil industry. The cements as received at the laboratory were placed in air-tight containers, and promptly labeled by name, date of arrival, and type.

A slurry of standard consistency, as determined by the A.P.I. ring test, was prepared by adding the given weight of cement to the required amount of water in a two-quart jar, and shaking according to the standard procedure for two minutes. The contents were poured into a 2-in. brass cube gang mold, puddled to liberate entrained air, and leveled. The molds were then placed in the constant temperature water bath at 150°F. and cured seven days.

After seven days curing, the cubes were taken from the bath, cooled to room temperature, and transferred to the durability chamber and the durability crocks.

A durability chamber was installed on the discharge line of one of the Dow Chemical Company brine wells. A portion of the salt brine being discharged from the well was bypassed through the durability chamber, which consisted of a 10-in. pipe 6 ft. long, containing three angle-iron frame screen sliding shelves

"MAN-HOURS"
—the misleading measure of production

It requires but one eye to see that man-hours alone are no measure of production. The thing that counts is how much that man can produce in one hour.

ALTER EGO: Sure. By one method he may produce two or three times as much per hour as by another method.

Take arc welding. This method results in far greater effectiveness. In joining steel, one welder does the work of two, three or four men using other methods. And he does a better job with 15% to 25% less steel.

ALTER EGO: Then it would seem a better measure for a company's contribution to the war effort would be METHOD-HOURS.

True as gospel. Our whole war production has been zoomed by those who grabbed arc welding as the only way to save our national neck.

ALTER EGO: And later they'll be schooled in an art to save their individual necks when competitive production again seeks profitable markets.

THE LINCOLN ELECTRIC COMPANY
CLEVELAND, OHIO

ALTER EGO: Literally, "one's other self"—the still, small voice that questions, inspires and corrects our conscious action.

then I said to myself—
IT'S METHOD-HOURS THAT COUNT!

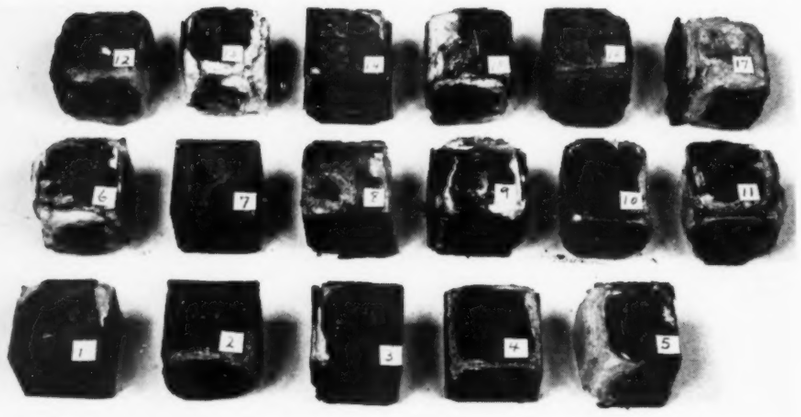


Fig. 1. Special oil-well cements, Portland and acid-soluble cements exposed for 90 days in Michigan brine

Sample No.	Cement	Sample No.	Cement	Sample No.	Cement
1	KK	6	GH	12	X
2	DD	7	ASC	13	XH
3	PP	8	B	14	D
4	CC	9	F	15	DH
5	G	10	M	16	Z
		11	MH	17	K

GENERAL SYMBOL CODE

Portland cements ..... Single letters
Special oil-well cement ..... Double letters
High early cements ..... Two letters ending in H
Lumnite cement ..... LUM
Acid-soluble cement ..... ASC

All symbols with the same first letter are from the same manufacturer, for example, C, CC, and CH are Portland, special oil well, and high early cements from one manufacturer.

to hold specimens. Brine containing approximately 30 percent total solids passed through the chamber at the rate of 26,000 gal. per day.

The other natural brines and 6 percent solutions of the various salts were placed in 20-gal. stone crocks and maintained at room temperature.

The labeled specimens with and without admixtures were carefully placed in the durability chamber and a diagram made of their location. The remaining solutions and specimens were set aside and inspected weekly. As previously determined, immersion of 90 days is in most cases sufficient to get good comparative results, although in several cases it was necessary to subject the specimens to two or three tests before any definite conclusions could be obtained.

The durability test program has included acid-soluble cement, Portland cement, high early cements, lumnite, and special oil-well cements. Addition agents such as fly ash, vinsol, silex, fish oil, stearate, puzzolith, natural cement, aquagel, calcium chloride, turkey red oil, orvis, and others have been incorporated in varying quantities. Also included was the variation of the water-cement ratio.

Results

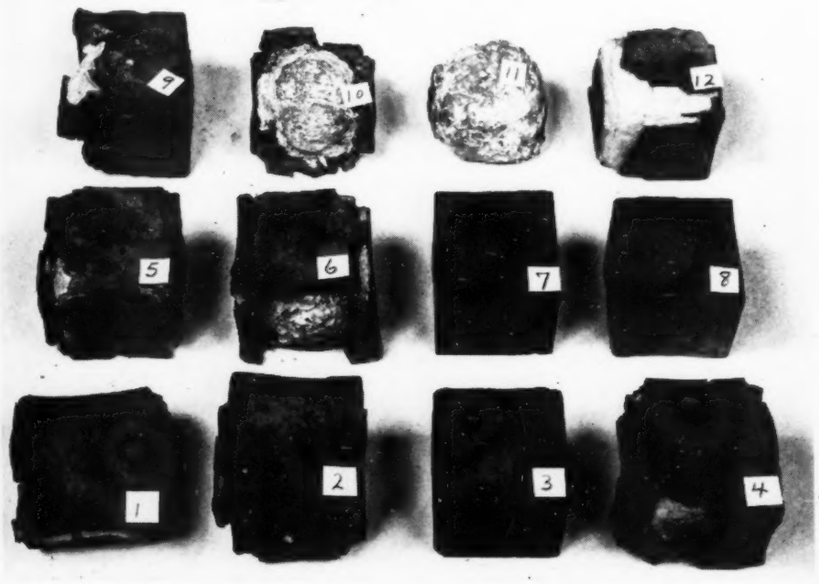
Of all neat cements tested to date, the acid-soluble cement and lumnite cements are the most resistant to salt brines. The resistance of lumnite cement lies mainly in the fact that because of its low lime content, it hydrates without forming compounds easily altered by contact with brine. The resistance of acid-soluble cement is due mainly to the Puzzolanic reaction of the carbonate with the active lime of the cement to form a new desirable compound.

Cements containing fly ash are considerably more resistant to brine and salt solutions than those containing other adjuncts as tested.

Fly ash, which is the residue of burnt, powdered coal, was obtained from six different sources and were different mainly in the particle size and carbon content. The proportion of fly ash used as a replacement for cement varied from 1 to 75 percent in steps of 1-3-5-10-20-25-30-50-75 percent. The maximum strength and durability with all cements tested was obtained with 20 percent fly ash having a low carbon content of approximately 2 percent carbon and a surface area of about 2600 sq. cm. per gram, although fly ashes of higher carbon content and with surface areas of 800 sq. cm. per gram and finer showed marked improvement in the resistance to brines. Fly ashes of moderately low carbon content and a high fineness will form a Puzzolanic reaction, thus improving the quality of the cement. The Puzzolanic reaction in cement is quite

Fig. 2. Cements containing addition agents and various brands of Portland and special cements exposed for 90 days in Michigan brine

Sample No.	Cement	Sample No.	Cement	Sample No.	Cement
1	K+0.05% vinsol resin	5	C	9	CC+3% bulking agent Z
2	B+0.05% fish oil stearate	6	DD	10	CC
3	ASC	7	LUM	11	CC+0.75% bulking agent B
4	B	8	OO	12	PP



Bucyrus·Erie spudders

are hellcats for wildcatting!

36-L

Handles 5,000 pounds of tools to over 2,000 feet, 3,200 pounds on ⅞ inch line to over 5,000 feet. Will pull 4,200 pounds from 3,000 feet in 8 minutes, or a 7 inch by 30 foot bailer from 3,000 feet in 3 minutes 128 H.P. engine, 54-foot telescoping mast will take 50,000 lbs. static load.

24-L

Handles up to 2,400 pounds of tools. Has ample capacity to drill and swab to 2,000 feet. Average hoisting speed on bull reel is 290 fpm. Chain-driven sand reel has average hoisting speed of 900 fpm. Telescoping derrick available in 40 and 48 foot lengths. Gasoline engine develops 48 to 1,600 rpm.

Also smaller sizes suitable for shallow wells, seismograph drilling, etc.

COMPLETE SELF-CONTAINED UNITS When you move a Bucyrus-Erie rig, you move **everything** in one load. Mast, bull reel, power machinery . . . they're all there together, marvels of efficient compactness, in this complete self-contained drill.

EASILY PORTABLE You can buy the 24-L with truck mounting; both models are available with semi-trailer mountings or with steel wheels; and both have flat-bottom frames for skidding onto derrick floor.

QUICK SET-UP All-welded telescoping masts with gear-driven power winch on 36-L, hand-operated high-ratio gear hoist on 24-L along with folding braces on both models make setting up easy, quick.

RUGGED CONSTRUCTION All machinery is held in enduring alignment in rigid all-steel electric-welded fully-trussed box frames. High carbon steel jack shafts, extra large clutches, and other features make these rigs plenty tough.

SPEED Long lever arm of beam gives long stroke; rubber shock absorber smooths out vibration, softens jerk-back; and puts snap into action at bottom of hole. Result is exceptional drilling speed.

HANDY OPERATION All control levers together in one convenient spot, no temper screw to bother with; you can stop drilling and start pulling tools in less than ten seconds. All parts are readily accessible, adjustments simple.

GASOLINE, NATURAL GAS OR DIESEL POWER A power unit to suit your requirements. Units fully enclosed to protect from weather and dripping lines. Engine drive is through an endless compass-cord belt with heavy idler pulley.

BUCYRUS-ERIE COMPANY
SOUTH MILWAUKEE, WISCONSIN
Sales Offices and Distributors in all principal oil territories

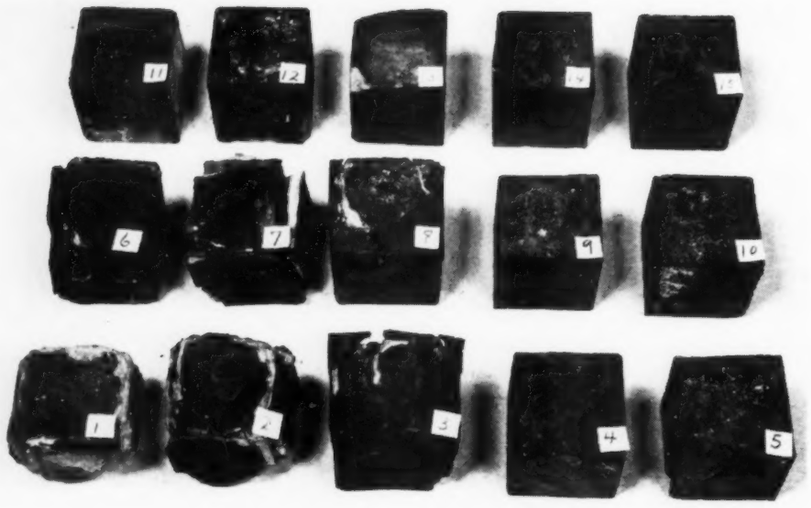


Fig. 3. Portland and acid-soluble cement containing silex and fly ash exposed for 90 days in Michigan brine

Sample No.	Cement	Sample No.	Cement	Sample No.	Cement
1	K	6	M	11	ASC
2	K+20% silex	7	M+20% silex	12	ASC+20% silex
3	K+30% silex	8	M+30% silex	13	ASC+30% silex
4	K+20% fly ash	9	M+20% fly ash	14	ASC+20% fly ash
5	K+30% fly ash	10	M+30% fly ash	15	ASC+30% fly ash

complicated, but it is generally accepted that when Portland cement hydrates, certain complex reactions take place, freeing a water-soluble highly reactive lime. It is with this active lime that the silicates of the Puzzolanic materials combine to form a new calcium silicate compound and prevent the formation of a crystalline aluminate type material that is readily acted on by brines.

A visual idea of the durability of some of the cements tested can be obtained by inspection of the photographs shown in Figs. 1, 2, 3, and 4. In Fig. 1, which shows the results of immersion of various cements in Michigan brine for 90 days, the acid-soluble cement specimen (No. 7) is the most resistant to attack and is the only specimen in the entire group that was substantially unaffected by the test. The special oil-well cements (Nos. 1, 2, 3, and 4) show somewhat less disintegration than the Portland and high early cements (Nos. 5, 6, and 8 through 17).

Fig. 2 shows the effect of Michigan brine on a number of Portland cements, special oil-well cements, and cements containing additive agents. Samples 3, 7, and 8 are the only ones that withstood the test without substantial disintegration. These samples were, respectively, acid-soluble cement, lumnite cement, and calcium sulphate.

Fig. 3 shows the effect of silex and fly ash on the durability of two Portland cements and on acid-soluble cement. Silex is a pure grade of silica and fly ash is a residue obtained from the combustion of powdered coal. The addition of fly ash in quantities of 20 or 30 percent decidedly improved the durability of the Portland cements, but this is not true for silex. Acid-soluble cement without addition agent (No. 11) is far more resistant to attack by brine than the two Portland cements (Nos. 1 and 6).

The durability of seven high early cements in brine, sodium sulphate, and magnesium sulphate solution is shown in Fig. 4. Sample 1 (cement LH) appeared fairly good in Michigan brine and sample 17 (cement MH) appeared fairly good in sodium sulphate solution, but, in general, these seven high early cements seem to be rapidly attacked and disintegrated by all three solutions.

The behavior of a cement in oil-well brines depends on the individual characteristics of the cement itself, as different cements will vary in chemical composition, degree of fineness, and water-cement ratio, and on the nature of the brine. The most harmful effects to cement are due to sulphates in the brine, as they act on the aluminate compound. The sulphites are also very hazardous, due to their tendency to oxidize and form sulphates. Magnesium chloride in brine plays an important part to bring about destruction to cements. Hydrogen sulphide, which commonly occurs in oil wells, is very destructive to cement, as it combines with the calcium to form a hydrosulphide.

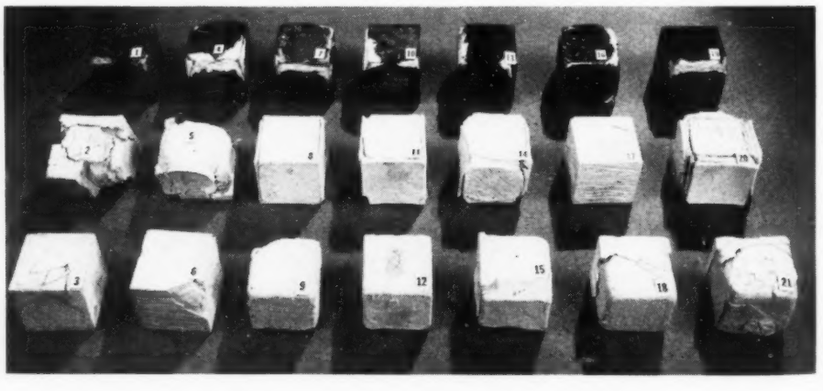
Durability is also definitely related to water-cement ratio, as cements containing low water ratio showed a marked degree of resistance.

It is obvious from the nature of the reaction of the brines that the chemical reaction depends mainly on lime, alumina fineness, and water ratio of the cement; in order to prevent the attack of corrosive brines, ordinary cement is made resistant by the addition of suitable adjuncts or a specially designed cement is used.

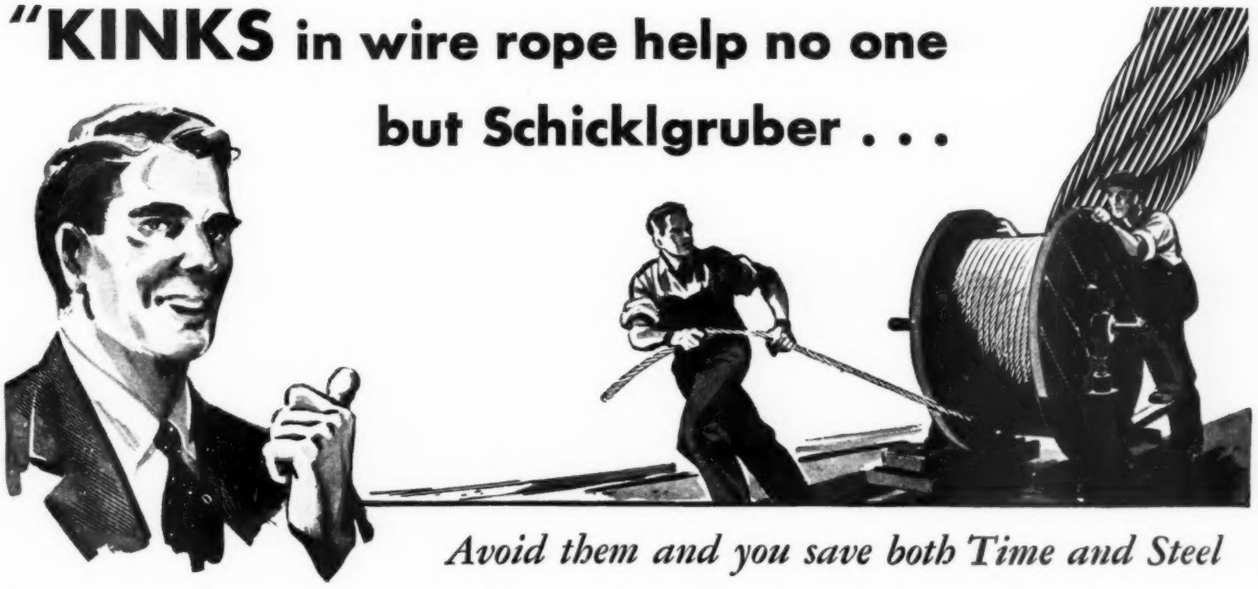
☆ ☆ ☆

Fig. 4. High early cements exposed for 90 days in Michigan brine, 6 percent sodium sulphate, and 6 percent magnesium sulphate

Michigan brine		6 percent sodium sulphate		6 percent magnesium sulphate	
Sample No.	Cement	Sample No.	Cement	Sample No.	Cement
1	ZH	2	ZH	3	ZH
4	EH	5	EH	6	EH
7	FH	8	FH	9	FH
10	DH	11	DH	12	DH
13	GH	14	GH	15	GH
16	MH	17	MH	18	MH
19	CH	20	CH	21	CH



"KINKS in wire rope help no one but Schicklgruber . . .



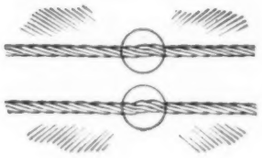
Avoid them and you save both Time and Steel

To the experienced wire rope user it may sound trite to say wire rope is a costly machine and must be treated as such. But there may be young fellows under you handling Roebling rope today who haven't learned by experience, and it's up to you to see that nothing they do will waste the valuable time and rope steel so vitally needed. Unloading the reel is just one way that a beginner may damage a rope. So tell him first that a reel of rope, like a motor or other piece of valuable equipment, should be handled carefully and not dropped from a truck or platform. Nor should it ever be moved by *prying against* the coiled rope.

But it's in kinking that the most serious damage is likely to occur. A kink starts as a loop like this!

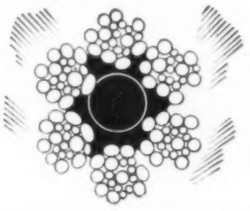
If it gets pulled tight, the damage has been done. The uniform relative position of the strands and wires has been disturbed—causing unequal stress distribution and abrasive wear that brings early failure at this point when the rope is put to work.

Even though you think you've straightened out a kink, looseness and high strands will appear. Because as the rope straightens after kinking, an extra twist is thrown into the strands that can never be removed. Here's a kinked rope under 10,000 pounds tension, and below it the same rope after the tension had been relieved . . .



But notice that the kink remains. That means very severe abrasive wear on the high strands and abusive strain on the drawn strands since they carry more than their share of the load. To show you what happens to the drawn strands inside the rope, here is one cut through at the kinked section.

Notice how the hemp center is compressed; some strands are drawn in and others forced out.



All right, kinks are wasteful . . . but it's just as easy to avoid them as it is to put them in. Remember, kinks start as loops—caused in most cases by taking rope from a stationary reel or coil. *The remedy is simple*—always unwind wire rope straight ahead by rotating the reel or coil. Don't let the reel get going faster than your rope is coming off. Always keep some tension on the rope if at all possible. Most people put a shaft through the center of the reel and jack it up—as shown in the big illustration at top. If it's in a coil, simply roll it along the floor like this . . .

It's as easy as that to avoid kinking during installation (where most kinks occur). Have these rules followed by every man who handles it, and you'll be on the way to getting all the *extra* service that's built into every inch of wire rope that bears the Roebling trademark."

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Design and Operation of Cycling Plant Absorption Systems*

☆ **Discussion of the construction and efficiency of different types of absorbers—Determination of absorption oil rate for known conditions**

by Elmer T. Neill

IT IS the purpose of the writer in this article to assemble information on absorption that will benefit engineers concerned with cycling plant design and operation.

There are numerous types of absorption, such as the absorption of a gas by a solid, the absorption of a liquid by a solid, the absorption of a gas by a liquid, etc. The type members of the cycling industry are most interested in is of course the absorption of a gas by a liquid. This article is, therefore, limited to that type.

The absorption of a gas by a liquid, provided the liquid does not chemically react with the gas, is relatively simple. Fundamentally, two simple laws of chemistry apply: first, Dalton's law, and second, Henry's law. Dalton's law states that in a mixture of gases the pressure exerted by any one of the components is equal to the pressure of the component if it were occupying the same volume as the mixture and under the same conditions of temperature and pressure, and the total pressure of the gas mixture is equal to the sum of the pressures exerted by the several components. Henry's law states that the pressure exerted by a component of a solution is equal to a constant times the concentration of the component in the solution:

$cK = p$

Where:

c = mol fraction of the component in the solution,

K = a constant, and

p = vapor pressure exerted by the component in the solution.

In the simplest case K is equal to the vapor pressure of the pure component, and in that case Raoult's law is said to apply.

The following hypothetical problem will best illustrate the use of these two laws.

If 100 mols of a liquid A having a negligible vapor pressure and 100 mols of a gas B having a vapor pressure of 100 lb. per sq. in. at the prevailing temperature, and mixed with 900 mols of an inert gas* are placed in a closed vessel under pressure of 100 lb. per sq. in., how many mols of B are absorbed by the liquid?

At equilibrium:

$P X = p_1 = p_2 = \pi y$

Where:

P = vapor pressure of pure component B,

X = mol fraction of B in liquid at equilibrium,

p_1 = vapor pressure of B in solution with A,

p_2 = partial pressure of B in gas,

π = total pressure, and

y = mol fraction of B in gas at equilibrium.

If P = 100 lb. per sq. in.

X = ? unknown

Z = ? unknown = mols of B absorbed by A,

Then:

$X = \dfrac{Z}{Z + 100}$ and

$y = \dfrac{100 - Z}{(100 - Z) + 900}$

Substituting:

$$\frac{100\,Z}{Z + 100} = \frac{100\,(100 - Z)}{(100 - Z) + 900}$$

$100(Z)(100-Z) + (900)(100)(Z) = Z(100)(100-Z) + (10{,}000)(100-Z)$

$90{,}000(Z) = 1{,}000{,}000 - 10{,}000(Z)$

$100{,}000(Z) = 1{,}000{,}000$

Z = 10 mols of B absorbed by A

Often in the petroleum industry it is necessary to calculate the quantities of the different hydrocarbon fractions that condense under specific conditions of temperature and pressure in the presence of other hydrocarbons, and, likewise, the quantities of these same fractions that would weather under other conditions of operation. Just such calculations of condensation are really again merely calculations of absorption using the two fundamental laws mentioned previously.

Liquid Phase Composition

If a mixture of hydrocarbons of the composition shown in Table 1 is placed under a pressure of 315 lb. per sq. in. abs. at 90°F., what will be the composition of the liquid phase?

Let:

π = absolute pressure,

P = vapor pressure of pure component,

Z = mols of component in liquid,

N = total number of mols condensed, and

$Z/n = x_n$ = mol fraction in liquid.

From Raoult's and Dalton's laws:

$X_n P = Y_n$

$N = Z_1 + Z_2 + Z_3 \ldots\ldots + Z_n$

$$ZP/N = \frac{(\text{total mols of component} - Z)\,\pi}{(100 - N)}$$

$N/(100-N) =$

$ZP/(\text{total mols of component} - Z)\,\pi$

$$N/(100-N) = \frac{Z_1(4150)}{315(62.43 - Z_1)}$$

ELMER T. NEILL

received his B.S. degree in chemical engineering from the University of Texas in June, 1940—Worked for the Coronado Corporation as a cycling plant operator from June, 1940, to September, 1941, when he returned to the University of Texas to work toward his masters degree in chemical engineering—For the last year he has also helped design much equipment for the new Chemical Engineering Building at the University.

*This paper was presented at a meeting of the Petroleum Industries Association, a group of company engineers and others in the general vicinity of Corpus Christi, Texas, who are interested in studying some of the many drilling and production problems encountered in this strategic area.

*By inert gas is meant a gas having a vapor pressure so large that a negligible amount will be absorbed.

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▶ **Precision quarter-marked end**—simplify layout and help insure accuracy.

▶ **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.

▶ **Wall thickness never less than specification minimum**—assures full strength and long life.

▶ **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.

▶ **The most complete line of Welding Fittings and Forged Steel Flanges in the world**—insures complete service and undivided responsibility.

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BOTH mathematical calculations and practical tests* prove that the bursting stresses in an elbow are greatest at the crotch or inner wall. That's why a special process is employed in producing WeldELLS which provides extra metal in this region of greatest stress as pointed out above. It is the nearest possible approach to the "One Hoss Shay" ideal of absolutely uniform strength throughout.

And it's also one more example of the length to which we have gone in producing WeldELLS to follow sound engineering considerations—considerations which mark the difference between right and nearly right.

An extra value, this—and opposite are listed other extra-value features that are combined in no other fittings for pipe welding. Yet: WeldELLS cost no more!

* The amount by which stress is greater at the crotch in a fitting having uniform wall thickness depends only on its radius. Mathematical analysis (specifically the Lorenz formula) shows the stress at the crotch to be:

$$S = \frac{pr\,(2R - r)}{2t\,(R - r)}$$

Where S = Bursting stress, lbs. per sq. in.
p = Internal pressure, lbs. per sq. in.
r = ½ inside diameter of fitting (O.D. if Barlow's formula is desired).
t = Wall thickness in inches.
R = Center line radius of fitting, inches.

Numerous tests by the Research Division of Taylor Forge show the formula given above to be somewhat on the conservative side.

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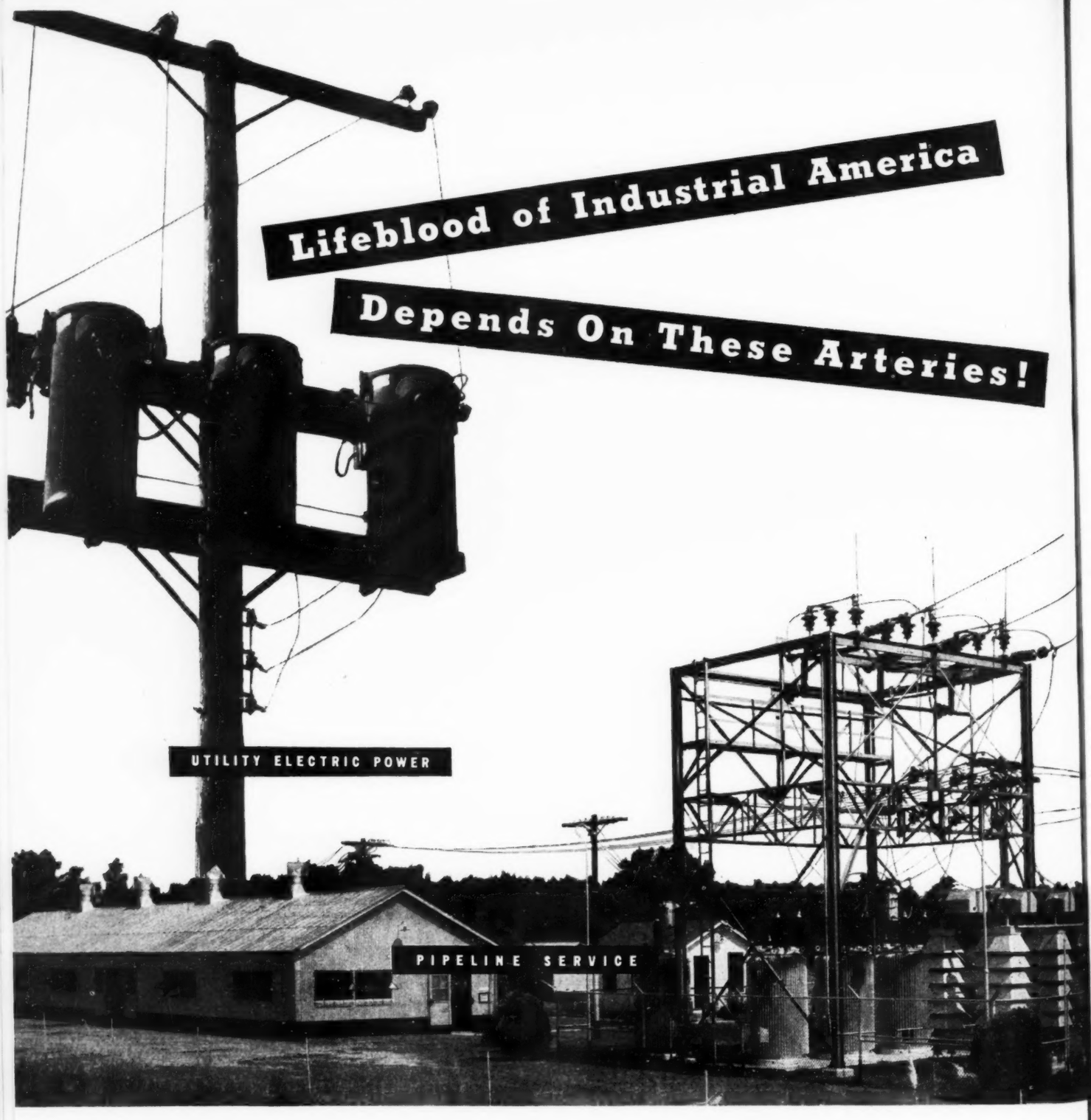

● You've seen charts of the circulatory system of the body, haven't you, showing how the blood circulates through the entire network of arteries and veins? Roughly, that's how your Utility Electric Power supply functions—a great network of arteries and veins supplying vital power for war industry. Similarly, the pipeline industry is a veritable network of arteries, conveying precious oil and gasoline to important sources of supply. Combined, these two industries form the lifeline of industrial and mechanized America. Each is doing everything possible to hasten the victory that is sure to come. Working hand in hand, we'll keep the *power* and the *oil* flowing!

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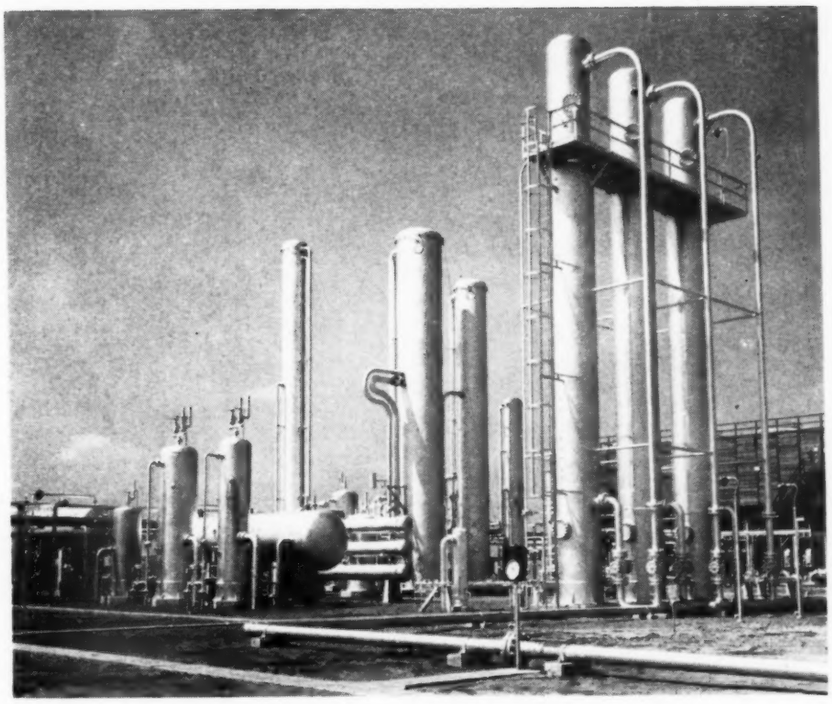

High-pressure absorber installation in South Texas cycling plant

$$= \frac{(13.17)Z_1}{62.43-Z_1}$$

$$N/(100-N) = \frac{Z_2(725)}{315(9.14-Z_2)}$$

$$= \frac{(2.3)Z_2}{(9.14-Z_2)}$$

$$N/(100-N) = \frac{Z_3(155)}{315(17.77-Z_3)}$$

$$= \frac{(0.492)Z_3}{17.77-Z_3}$$

$$N/(100-N) = \frac{Z_4(59)}{315(2.03-Z_4)}$$

$$= \frac{(0.187)Z_4}{(2.03-Z_4)}$$

$$N/(100-N) = \frac{Z_5(43)}{315(3.81-Z_5)}$$

$$= \frac{(0.137)Z_5}{(3.81-Z_5)}$$

$$N/(100-N) = \frac{Z_6(8.20)}{315(4.82-Z_6)}$$

$$= \frac{(0.026)Z_6}{(4.82-Z_6)}$$

Different values of N are assumed, as in Table 2, and the proper solution of the problem is obtained when N exactly or very nearly equals the sum of Z_1—Z_6, as when $N = 11.5$, $\Sigma Zn = 11.512$

In this problem, therefore, the following quantities of the fractions shown will be condensed:

Methane, CH_4, $0.610/62.43 = 0.0098$; $0.0098 \times 100 = 0.98$ percent.

Ethane, C_2H_6, $0.489/9.14 = 0.0536$; $0.0536 \times 100 = 5.36$ percent.

Propane, C_3H_8, $3.71/17.77 = 0.209$; $0.209 \times 100 = 20.9$ percent.

*Iso*butane, C_4H_{10}, $0.833/2.03 = 0.410$; $0.410 \times 100 = 41.0$ percent.

Butane, C_4H_{10}, $1.85/3.81 = 0.486$; $0.486 \times 100 = 48.6$ percent.

Pentanes plus, C_5H_{12}, $4.02/4.82 = 0.834$; $0.834 \times 100 = 83.4$ percent.

If the total quantity of the gas is known, the number of cu. ft. of the different fractions condensing can be readily calculated and the number of gallons computed therefrom. This problem gives a very good illustration of a more practical use of calculations on absorption.

Types of Absorbers

Such principles as used in the two problems given are the basis for calculations concerning absorber design and operation. Before taking up the calculations on design and operation, it is best that something be said of the different types of absorbers and their construction.

One of the first types used and possibly the simplest and least expensive to construct is the filled type column. This is merely a cylinder literally filled with junk, pieces of broken brick, steel shavings, pieces of scrap iron, stone, and gravel to expose a large surface for mineral seal oil to come in intimate contact with the gas flowing from bottom to top. This type of absorber has the advantage of a small pressure drop through it, but also the serious disadvantage of channeling. Due to settling of the material with which the towers are filled there is a lack of proper distribution of the oil and gas. This disadvantage of channeling was remedied slightly by reducing the diameter and increasing the height.

A decided improvement over the filled type absorber was made by the use of wooden grids in the towers instead of junk. The area open to fluid flow was increased and there was less channeling. Some of these grids were made of redwood, some of cypress, and some of common pine. Unfortunately, however, the packing was found to have a short life; it would break from one cause or another and usually lodge in the fat oil pump suctions, plugging the lines and increasing pressure drops.

Another type of absorber used was the spiral—tile absorber. The Raschig ring was used as the packing. The rings were not arranged in the tower but just dumped in. Channeling was further reduced due to the rings having a diameter equal to their length. Still another type of packing was the vitrified tile packing. These tile were 3 to 4 in. in diameter and length; passing lengthwise through the tile were several peripheral passages to give a whirling motion to the gas and oil.

Plate Type Absorbers

Packed towers are not used extensively now in refineries and gasoline plants, but have been replaced by plate type columns. The plate type column is merely a column containing a number of superimposed sections separated by plates, the plates being so constructed that the vapor passing through them comes into intimate contact with the liquid on the plates. The liquid on a plate is discharged onto the plate below by means of downpipes, and the vapor passes upward through the plates,

(Continued on Page 62)

TABLE 1
Composition of gas

Gas	*Mols*	*Vapor pressure at 90° F.*
Methane and air	62.43	4150
Ethane	9.14	725
Propane	17.77	155
*Iso*butane	2.03	59
N-butane	3.81	43
Pentanes	4.82	82
Total	100.00	

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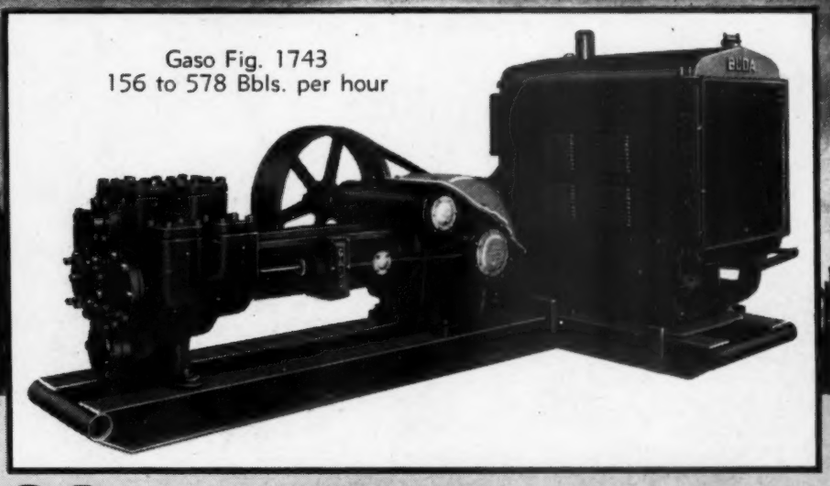

Gaso Fig. 1743
156 to 578 Bbls. per hour

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GASO PUMPS
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(Continued from Page 59)

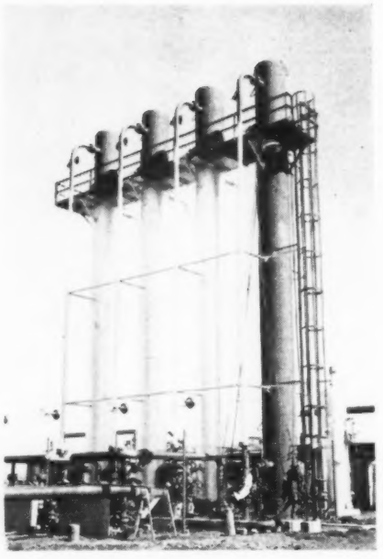
through the liquid, to the next higher plate in the column, and so on.

As there are different types of packing for packed columns there are likewise different designs of plates for plate columns. The simplest of these is the perforated plate. This type consists of plates with a large number of holes through which the gas may pass upward and the usual vaporsealed down pipe on each plate to maintain a liquid level and to allow passage of the liquid to the plate below. The gas passes upward through the holes, preventing the liquid from coming through. The liquid passes through the down pipe on the side opposite the point at which it was introduced to the plate. This type of plate is efficient if the holes are very small and very close together. The gas velocity must be sufficiently high so that the pressure at each tray exceeds the static head on the tray, in order to prevent the liquid from passing downward through the vapor holes. If the velocity is too great, however, the vapor tends to lift the liquid from the plate and destroy the intimate contact between vapor and liquid that is essential to maximum efficiency of the plate. Another difficulty, particularly in columns of large diameter, is that liquid collects at the lower part of the plate if the plate is not horizontal. The vapor will tend to pass in large volumes through the holes in the higher part of the plate, where the liquid head is less, resulting in poor contact.

Bubble Tower

The next step toward better plate design involved the use of a liquid seal on the plate. Liquid-tight rings were placed around the holes of the plate thus preventing the liquid level from getting lower than the top of this seal. Covers were then placed on the rings, thus forcing the gas to descend below the liquid level and bubble up through the liquid. This type of plate was found to be much more efficient because of the more intimate contact obtained by bubbling the vapor through the oil. It is from this action that the bubble tower derives its name.

The efficiency of the bubble plate was enhanced by cutting numerous slots in the shape of a parallelogram in the circumference of the bubble caps, the top portion of the slot being smaller than the lower portion. The more deformed in shape the bubble passing through the liquid, the greater will be the exposed surface in contact with the oil, and the greater the efficiency. A number of different type slots including round and square holes, have been employed in different types of design. Very little difference in efficiency has been recorded, as all attain practically the same end; namely, the forming of a large contact surface between the liquid and the vapor.



High-pressure absorbers, two of which operate at 1500-lb. pressure and two at 2000-lb. pressure

Efficiency

The bubble column is the most efficient of the various types of absorption columns. In fact, it is used almost exclusively in gasoline plants and refineries today. Attempts have been made to increase the efficiency of this type column by increasing the depth of liquid on the plate. This increase in depth, of course, gives a longer period of contact between gas and liquid, and equilibrium on the plate is more nearly approached. It has been shown, however, that when a bubble emerges from an opening into a liquid, the vapor near the surface of the bubble reaches equilibrium with the liquid almost instantaneously, and the vapor in the interior of the bubble, not being in contact with the liquid, does not come into equilibrium with the liquid, except by diffusion of the vapor from the surface of the bubble. When a bubble is introduced into a liquid, it immediately assumes a spherical shape and, if allowed to rise through the liquid untouched, very little further reaction will occur. As the rate of diffusion of the vapor in the bubble is slow in comparison with the time of contact of the vapor and the liquid, an excess depth of liquid is of no material aid in increasing plate efficiency if the bubbles are allowed to rise through the liquid undisturbed. It can readily be seen, however, that if at any point or points in its passage, the bubble is deformed or broken, a fresh portion of the vapor is thereby brought into contact with the oil at the surface of the bubble, and equilibrium between an additional amount of the vapor and the oil will result. Consequently, if the efficiency of a column is to be appreciably increased by an increase in depth of liquid, it is necessary to supply a means of further deforming the bubbles as they pass upward through the liquid.

It has been shown by frequent tests that the higher the vapor velocity, the greater the efficiency of a bubble plate column due to the increased deformation of the bubbles. Efficiency increases to a certain point, then begins to decrease due to the excessive quantities of the liquid being forced off the plate and the area of contact consequently being reduced. Practically, this point is that at which the liquid is carried from one tray to the one above.

The pressure drop between any two plates of a column depends on three factors and is the sum of the pressure drops caused by these three factors: depth of liquid on the plate, velocity of the gas through the cap slots, and friction of the vapor passing through the slots and liquid.

Pressure Drop

The pressure drop due to friction is negligible when the velocity of the gas through a slot is less than 100 ft. per sec.; inasmuch as the usual velocity is about 14 to 20 ft. per sec., the friction is not considered in pressure drop calculations. The pressure drop due to the cap slot velocity is calculated by use of the velocity head equation:

$$V = c\sqrt{2gh}$$

Where:

V = velocity in ft. per sec.,
c = constant with an average value of 0.30,
g = acceleration due to gravity (32.2 ft. per sec.), and
h = static head in ft. of gas.

In determining the static head of the liquid on the plate, it must be remembered that the total depth of liquid is not the effective head. The effective head is the distance from the center of pressure of the cap slots to the surface of the liquid. To calculate the pressure drop due to the head of liquid, multiply

TABLE 2

N	$\frac{N}{100-N}$	Z_1	Z_2	Z_3	Z_4	Z_5	Z_6	$\Sigma Z = N$
12	0.136	0.638	0.510	3.85	0.854	1.90	4.05	11.802
11.50	0.130	0.610	0.489	3.71	0.833	1.85	4.02	11.512
10	0.111	0.522	0.421	3.27	0.755	1.76	3.91	10.638

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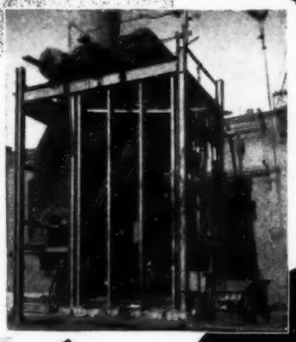

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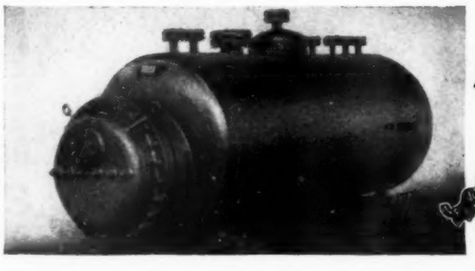

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TABLE 3

Capacity, 1000 cu. ft. of gas or vapor per bubble cap per 24 hr. of continuous operation

Gal. of oil circulating per M. cu. ft.	Density of vapor or gas, lb. per actual cu. ft.										
	0.02	0.06	0.10	0.20	0.40	0.60	0.80	1.0	2.0	4.0	6.0
30	170	155	145	130	115	105	97	90	76	63	55
35	155	150	130	120	105	95	87	80	70	57	50
40	145	130	120	110	96	87	80	74	63	52	46
45	135	120	110	100	90	80	75	69	59	48	42
50	125	110	105	95	83	75	70	64	55	45	40
55	115	105	97	90	78	71	65	60	52	42	37
60	110	100	93	84	76	67	62	57	48	40	35
65	105	95	88	80	70	64	59	54	46	38	33
70	100	90	84	76	67	61	56	52	44	36	32
75	95	85	80	73	64	58	54	49	42	35	30
80	92	82	77	70	62	55	51	47	40	33	29
85	88	80	74	67	60	54	49	45	39	33	28
90	85	76	72	65	57	52	47	44	38	31	27
95	82	73	69	63	55	50	46	42	37	30	26
100	80	71	67	60	53	48	44	41	35	29	25
125	69	62	58	52	46	42	38	36	30	25	22
150	61	55	51	47	41	37	34	32	27	22	19
175	55	50	46	42	37	33	31	29	24	20	17
200	50	45	43	39	34	31	28	26	22	18	16
250	44	40	37	34	30	27	24	23	19	16	14
300	39	35	33	30	26	24	22	20	17	14	12
350	35	32	30	27	24	22	20	18	16	13	..
400	32	29	27	25	22	20	18	17	14	12	..

the effective depth times the density of the liquid.

If, after considering the pressure drop due to the liquid head, it is found desirable to have a 1.60-lb. pressure drop due to the velocity head through an absorber having 16 trays the allowable velocity is calculated as follows:

P (through tower) = 1.60 lb.

1.60/16 = 0.10 lb. per plate

$V = 0.30\sqrt{2gh}$

Using a molecular weight of 30 for the gas passing and assuming atmospheric conditions:

30/380 = 0.079 lb. per cu. ft. (density of gas at 14.67 lb. per sq. in. atmospheric pressure and 60°F.)

L = 0.10/0.079 × 144 = 182

V = 0.30 (64.4) × 182

V = 0.30 × 108 = 32.40 ft. per sec.

The cap velocity of 32.40 ft. per sec. will give a pressure drop of 0.10 lb. per plate when passing a gas of a molecular weight of 30 and under atmospheric pressure and 60°F. When using that temperature, the figure 380 is used, but if 32°F. were used, 359 would be substituted as has been previously brought out.

Making the same calculation when operating under a pressure of 30 lb. per sq. in. gauge and an average temperature of 85°F.:

30/380 = 0.079 lb. per std. cu. ft., as above.

$$0.079 \times \frac{(460+60)}{(460+85)} \times \frac{(14.67+30)}{(14.67)}$$

= 0.079 × 520/545 × 44.67/14.67

= 0.23 lb. per actual cu. ft.

h = 0.10/0.23 × 144 = 62.6

$V = 0.30 \times \sqrt{64.4} \times 62.6$

V = 19.05 ft. per sec.

The calculation of bubble tower capacity is an important item in the design and operation of this type tower. The capacity is dependent principally upon several factors, among which are: distance between trays or plates, molecular weight of the gas or composite vapor mixture being treated or processed, and the absolute operating pressure.

The greater the distance between plates, the greater the capacity of the tower. Consequently, if the distance is made greater the diameter of the shell can be made smaller; but there is no saving in the cost of construction, as the increased tray space necessitates a higher tower. It has been found from experience in gasoline plants that 18 in. is the most economical spacing.

The molecular weight of a gas is a way of expressing its relative density. Thus, as the molecular weight increases, the shell and cap velocity must decrease; that is, a tower will process a greater quantity of gas having a molecular weight of 30, such as natural gas, than of one having a molecular weight of 125.

The third factor influencing absorber capacity is absolute operating pressure. Absolute pressure determines the density of gas; therefore, with an increase in absorber pressure, the allowable shell and cap velocity must decrease. Inasmuch as allowable velocity varies inversely as the square root instead of the first power of a change in density, an increase in pressure actually increases the weight capacity of the tower even though the volume capacity decreases. In other words, if 20 lb. of a gas at a pressure of 16 lb. per sq. in. can be processed in a given length of time, 40 lb. can be processed at 64 lb. per sq. in. in the same interval of time.

Velocity

In bubble towers, the allowable shell velocity is 2 ft. per sec. at atmospheric pressure and 18-in. tray spacing for a fluid of a molecular weight of 125. This velocity varies inversely as the ratio of the square root of the molecular weights and also as the ratio of the square root of the absolute operating pressures.

Consequently: (allowable velocity of a gas having a molecular weight of 30)

$2 \times \sqrt{125}/\sqrt{30} = 2 \times 11.2/5.48$

= 2 × 2.04 = 4.08 ft. per sec.

4.08 × 0.80 (factor of safety) = 3.26 ft. per sec. at atmospheric pressure, or, at 30-lb. gauge:

$3.26 \times \sqrt{15}/\sqrt{45} = 3.26 \times 0.577$

= 188

Now from the known allowable shell velocity the capacity in cu. ft. per 24 hr. can be calculated for any tower of known inside diameter. For example, calculate the capacity of a 32-in. I.D. absorber, treating gas of a molecular weight of 30 and at a pressure of 45 lb. per sq. in. abs.

$\pi r^2 = 3.1416 \times 256 = 804$ sq. in.

804/144 = 5.58 sq. ft. cross-sectional area.

5.58 × 3.26 = 18.2 std. cu. ft. per sec.

18.2 × 86,400 (sec. per 24 hr.)

= 1,572,500 std. cu. ft. per 24 hr.

At 45 lb. per sq. in. abs. pressure:

Allowable velocity = $3.26 \times \sqrt{15/45}$

= 1.88 ft. per sec.

1.88 × 5.58 × 86,400 = 906,000 actual cu. ft. per 24 hr.

906,000 × 45/15 = 2,720,000 std. cu. ft. per 24 hr.

Consequently, for a 60-in. absorber treating gas under the same condition:

3.1416 × 900 = 2830; 2830/144 = 19.7 sq. ft. cross-sectional area.

19.7 × 1.88 × 86,400 = 3,200,000 actual cu. ft. per 24 hr.

3,200,000 × 45/15 = 9,600,000 std. cu. ft. per 24 hr.

Heretofore, nothing has been said about the variation of bubble tower capacities as related to liquid circulation. This can be more readily seen in Table 3.

In Table 3, the capacities are given in 1000 actual cu. ft. per cap per 24 hr. The cross-sectional area of the cap open to flow to the gas or vapor is approximately 7 sq. in. The nominal number of caps in towers of different diameters is as follows:

Diameter of tower, in.	*No. of caps*
24	6
32	12
40	16
48	26
60	40
72	58
84	80
96	105
108	129
120	160

It can readily be seen that as the cross-sectional area of the cap used is decreased or increased, the number of caps in any given diameter of tower will increase or decrease. It can further be seen that by the above, the correctness of the

diameter of any tower can be determined.

The following example is given to explain more fully the use of Table 3:

Gas capacity = 18,000,000 std. cu. ft. per 24 hr.

Gas mol. wt. = 30

Operating press. = 30 lb. gauge (45 lb. abs.)

Gal. of oil per 1000 actual cu. ft. of gas being circulated = 100

Calculate the absorber capacity needed:

(18,000,000) (45/15) = 6,000,000 actual cu. ft. per 24 hr.

Gas density 30/380 = 0.079 lb. per std. cu. ft.

0.079 × 45/15 = 0.237 lb. per actual cu. ft.

In Table 3, it will be noted that for 100 gal. of oil circulated, the capacities per bubble cap for densities of 0.20 and 0.40 are 60,000 and 53,000 cu. ft., respectively. From this, it is apparent that each cap under the above conditions will have a capacity of approximately 58,000 actual cu. ft. of gas or vapor per 24 hr.

Therefore, 6,000,000/58,000 = 104 caps required to handle the amount of gas.

Consequently:

One 96-in. unit having 105 caps, or two 72-in. units each having 58 caps would serve; however, the first would be more economical from the standpoint of first cost.

It seems unnecessary to say that the oil circulation of a gasoline plant is one of its most important factors and should be determined as accurately as possible. The formula to determine this circulation of oil is:

Oil rate, gal. per min. = A × M × V. P./(18 × P.)

Where:

M = number of 1000 cu. ft. of gas to be treated per day,

V. P. = Vapor pressure, lb. per sq. in. abs., of *iso*pentane, at the temperature of the fat oil leaving the absorber,

P = Abs. outlet absorber pressure, lb. per sq. in., and

A = Absorption factor, 1.40 for a 16-plate absorber and 1.60 for a 12-plate unit.

By using the above formula it is possible to determine the oil rate for any given set of conditions. At the same time, it must be borne in mind that for each percentage saturation of the fat oil, there is an increase in the temperature of the lean oil. In other words, for a fat oil saturation of 4.0 percent, its temperature would be 10°F. higher than that of the lean oil entering the absorber. The vapor pressure of *iso*pentane used in the above formula would be its vapor pressure at the latter temperature. If the gas analysis shows none of this constituent, it is satisfactory to use the vapor pressure of the pure pentane fraction in the formula.

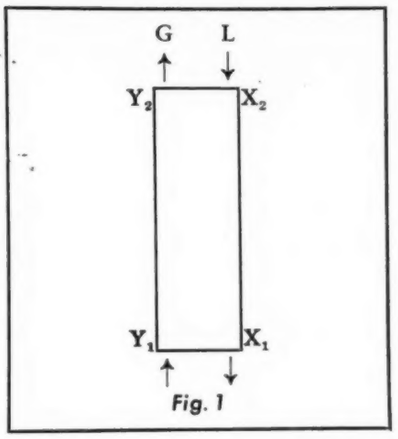


Fig. 1

To calculate the fat oil saturation, the following formula is useful:

$$\text{Percent fat oil saturation} = \frac{\text{Gal. gasoline produced per day} \times 100}{\text{Lean oil circulation, gal. per day}}$$

gasoline produced

In the design of bubble towers one of the most important determinations is the number of trays to use. This is done by the use of the equilibrium curve of the gas and liquid absorbent and the straight line material balance curve.[1] (Fig. 1.)

The equation of the material balance curve is:

$$G(Y - Y_2) = L(X - X_2)$$

Where:

G = mols of solute-free gas

L = mols of liquid absorbent

Y_2 = concentration of outgoing gas as mols of solute per mol of solute-free gas

Y = concentration of gas at any point in tower as mols of solute per mol of solute-free gas

X_2 = concentration of incoming liquid as mols of solute per mol of absorbent

X = concentration of liquid at same point Y is taken as mols of solute per mol of solute-free absorbent.

This equation is easily understood if it is remembered that for every mol of solute absorbed the gas has to give up one mol.

The equilibrium curve, Y in mols per mol plotted against X in mols per mol, is obtained either by calculating points on the curve or by experimentation. In some cases the curve can be calculated by the use of the following equation, which is derived from Dalton's and Henry's laws:

$$Y = \frac{HX}{\pi - (H - \pi)X}$$

Derived as follows:

$p = Hx = \pi y$

but:

$$x = \frac{X}{1+X}; \text{ and } y = \frac{Y}{1+Y}$$

then:

$$\frac{HX}{1+X} = \frac{\pi Y}{1+Y}$$

$$Y = \frac{HX}{\pi - (H - \pi)X}$$

The number of plates as found by this method are theoretical plates; that is, it is assumed that the contact between the liquid and gas on a plate is sufficiently good that the vapor and liquid leaving a plate are in equilibrium with each other.

An example of plate determination is shown by Fig. 2.

Where:

Y_1 = concentration of incoming gas as mols of solute per mol of solute-free gas,

Y_2 = concentration of outgoing gas in same units,

X_1 = concentration of outgoing liquid as mols of solute per mol of solute-free liquid, and

X_2 = concentration of incoming liquid as mols of solute per mol of solute-free liquid.

Curve $OH_1F_2D_3B_4$ is the equilibrium curve and IGECA is the straight line material balance curve.

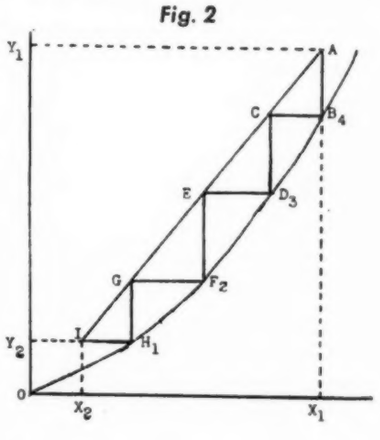
The slope of the straight line is L/G, or the liquid-gas ratio. Thus by inspection it is seen that as the ratio becomes smaller, more plates are required to give the same absorption. In other words, if less liquid absorbent is used per mol of gas, more bubble plates must be used in the absorber and vice versa.

Inasmuch as in actual practice the vapor does not come to equilibrium with the liquid on each plate, more than the theoretical number of plates determined are required. This inefficiency is somewhat offset, however, by the concentration gradient across the plate, a condition that was neglected in the definition of a theoretical plate. This gradient aids the operation, however, by making it more nearly countercurrent.

☆ ☆ ☆

[1] *Principles of Chemical Engineering*, by Walker, Lewis, McAdams, and Gilliland, 1937, p. 462.

Fig. 2



MIDWEST

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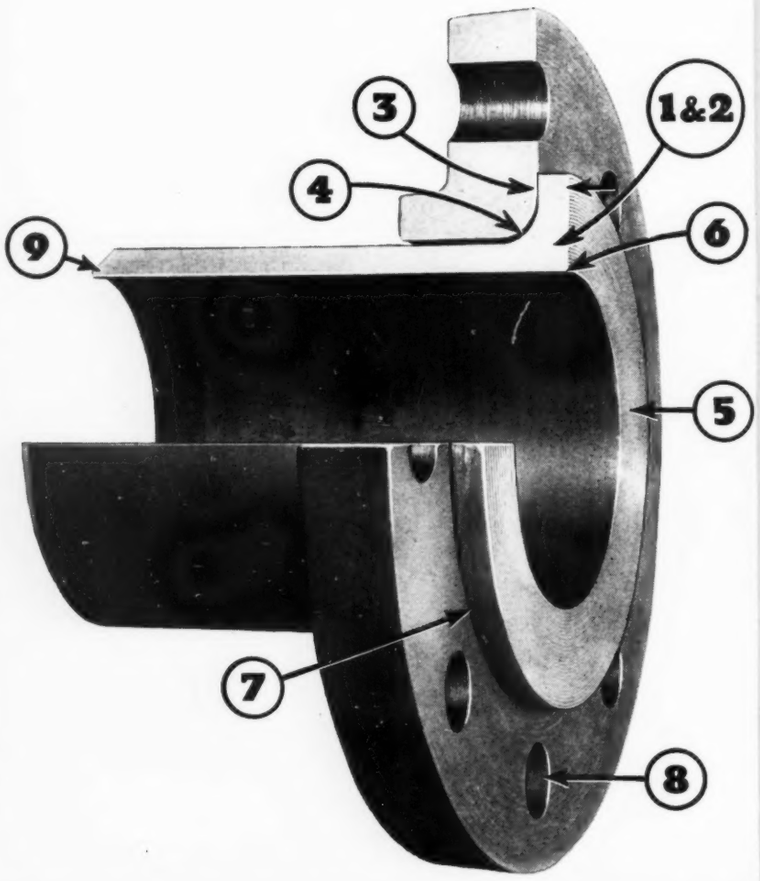

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☆ To American invention and industrial enterprise it has been the great contributing factor

by George T. Gill

THE goose that lays the golden eggs is slowly being starved. American inventive genius, which has contributed so much to our industrial advancement, American industrial enterprise that amazes the world and makes America powerful and wealthy is, and has been for a decade, on short rations. Now, there is in contemplation, by those who may, further and more drastic curtailments of the vital stimulant for inventive effort and industrial enterprise in the development of new products for new industries and the expansion of old industries. Unless care and forethought be exercised, the decadence of malnutrition may soon be evident and artificial stimulation required to maintain continued existence without advancement.

American inventive genius and American industrial advancement are as Siamese twins—inseparable, one dependent for continued life upon the other, commingling the fluid of life to contribute each his respective share in the growth and power that American industry has become and must remain if this nation is to continue to maintain its industrial prosperity and leadership. China and India have labor and resources in abundance. Many of their citizens are enterprising and ingenious. But there is lacking the incentive. Human nature is not such as to exert itself without incentive; it is not such as to deprive itself of its comforts unless by so doing there is a possibility of greater comfort; it is not such as to gamble what wealth it has without hope of greater wealth, greater wealth commensurate with the gamble taken. We Americans are human beings. As such we exert our efforts along the lines that offer personal advantages, just as all other human beings.

Inventive genius and industrial enterprise are not God-given gifts to Americans, to the exclusion of all others. It is a common heritage of the human race. It has been brought forward and developed to a high degree in those countries in which the proper incentive exists and has existed for many years. Once the Russian people were given a like incentive, they turned from a dormant nation to a powerful, industrialized nation. For any country to become or remain a powerful industrial nation, there must be an incentive to the people of the nation, as individuals, to exert themselves to acquire knowledge of industrial arts and sciences, to extend the available knowledge, to risk personal comfort, wealth, and labor in carrying forward industry.

GEORGE T. GILL

graduated from Rensselaer Polytechnic Institute in 1927 with the degree of electrical engineer—Appointed an assistant examiner of patents in August, 1927, and resigned in September, 1928—He studied law at Fordham University Law School from which he received the degree of bachelor of laws in 1931, then studied patent law at Washington College of Law—Was admitted to the bar of the State of New York in April, 1932, and has since practiced law specializing in patent law—Is a member of the bar of the United States District Courts for the Eastern and Southern Districts of New York and the United States Circuit Court of Appeals for the Second Circuit.

Incentive in Personal Gain

As a free people and a nation of free enterprise there is but one incentive to individuals to exert themselves in lines of endeavor that create wealth, such as industry. That incentive is personal gain, increased personal wealth. History adequately demonstrates this fact. Honor, position are not fructifying incentives. Wealth brings to a man a sense of security for himself and his dependents; it also brings position and power. Industry and trade have no other objective, no other purpose, and no other reason for existence but the creation of wealth, a greater abundance of the things desired by human beings. As that is so, the individual can be incited to exert himself in the expansion of old industries and the creation of new industries by the alluring prospect of greater personal wealth.

Early in its history, England realized the necessity for increasing its trade and industry in order that it might become a powerful and wealthy nation. Then, as now, it was known that there are certain emotions of man that can be appealed to in order to incite men to exert their abilities and to sacrifice their time and efforts in acquiring knowledge, and to risk their earnings acquired by their labors in extending trade and industry. England tried to play upon man's desire for honor and distinction. During the reign of Athelston (A. D. 925-94) England offered the distinguishing title of "thane" to anyone who would make three voyages in trade beyond the seas. It had little or no effect. Later, during the reign of William Rufus, a wiser government appealed to man's desire for personal wealth, and a most ingenious arrangement was devised—letters patent by which the crown agreed to grant the exclusive privilege of carrying on a trade or industry within the realm to him who introduced a new trade or industry into the realm. Trade and industry flourished, guilds and towns were formed for the purpose of engaging in trade and industry, people came from the continent to England to establish trades and industries known on the continent but unknown to England. From then on England prospered.

The system was ingenious as originally conceived. The people were not deprived of anything they had before, patents were only granted for new trades and industries introduced into England. There was no burden on the government because those who would procure a patent must, at their own expense, establish the trade or industry within the country. The charters under which America was colonized formed part of this system of granting letters patent.

Trade and industry developed rapidly because the individual saw in the exclusive privilege a way in which he could enrich himself. He sought out new industries, new trades at great expense to himself and established them in England on the chance that they would

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be successful there. Many were not and great losses occurred. But the gamble was worth it, for those that did succeed were not be-deviled by cut-throat competition. They could procure a return of the money paid out and recompense in proportion to the effort expended and the risk taken.

Today in all industrial countries this same system maintains, except that the grant of patents is limited to new and useful inventions in the industrial arts, and the grants, in the form of patents, are limited to a period of 17 years. Thus, the government says in effect, if you, by creative genius, devise something that is new, never been known before, and useful in the industrial arts, we will give you the right to stop all others from making, using, or selling the creation of your genius for a period of 17 years. What does it mean to the inventor? Simply this, if you exercise your creative ability, spend your time and your money that you have earned by your previous labors in developing your creation to a point where it is marketable, and then spend your money, time, and effort in procuring machinery, tools, and equipment for making the device, you shall not have any competition in the making, using, or selling of it for a period of 17 years. But when you have done all this and no one wants your creation at the price you must receive, what then? Even a failure in creation and development, from which the individual alone suffers a loss, contributes to the betterment of industry; it closes a line of endeavor and provides the very valuable knowledge that the line of endeavor does not advance industry.

Financial Risk Involved

There is a great risk in every undertaking of this kind. Some of our most valued industrial products required investments of large sums before it even could be determined whether the products would be the basis of successful businesses. General Electric Company gambled more than a million dollars in the development of Carboloy, the centered tungsten tool steel. At one time, it was losing money at the rate of one thousand dollars a day on the development of this material. Let us assume that this material finally could not be used satisfactorily or that before it became a marketable product a better material was found for the same purpose. General Electric Company would have lost a million dollars.

Instead it proves to be a great boon to our war effort. Without cost to the public or the government, we have an adequate supply of this most valuable material. Is not the General Electric Company entitled to regain the million dollars it invested in this material? Is it not entitled to a reasonable return in addition in accordance with the risk it took in investing its capital in the development of this material? That risk was great, the amount of money necessary to make the metal a marketable product is evidence of the fact that the risk was great. Unless it can so regain its development expense from that which through its efforts it brought into being, everlastingly to the benefit of this nation and its people, it would be foolhardy for it to undertake development work; it could not do so and exist. Yet it does gamble because it believes that the government through the patent grant will permit it to keep others from making what it creates and develops for a short period.

There have been many, many failures in the creation and development of new industrial products. The cost of developing and marketing even the simplest invention is such, and the number of hazards, unforeseeable hazards, that beset such an undertaking are such as to make the gamble of time, ability, labor, and capital enormous. If there be no hope of reward commensurate with the difficulties and gamble; if after the development be completed, a competitor who undertook nothing in creation and development could copy the creation, make and sell it, no man, no group of men, no corporation, however large or wealthy could undertake the creation and development of new products. The incentive would be gone, invention and industrial development would die and industry would linger on the bones of the goose to hunger and languish in its misery.

Patent System Contributes to Enterprise

That the patent system has been the great contributing factor to American invention and industrial enterprise is not doubted by anyone familiar with it and its operation. President Wilson, in the "World's Work," January, 1913, "The New Freedom" on page 259 said, "The Treasury of America . . . depends upon the inventions of unknown men, upon the organization of unknown men, upon the ambitions of unknown men." More recently, the present Commissioner of Patents, the Honorable Conway P. Coe, speaking at a hearing before the Temporary National Economic Committee stated that "nearly every major industry in the United States . . . owes its existence to inventions once protected by patents. In short, every industry in America . . . (is) beholden to patents." The chairman of this committee, Chairman O'Mahoney remarked, "The fact that patents are keystones in many very important industries has been brought home to us with great emphasis. I doubt whether I had realized their significance as a primary force in the operations of the economic system." Last December (December 12, 1941; Federal Register, December 17, 1941), President Roosevelt signed an order establishing the National Patent Planning Commission. The preamble of this order states in part: "Whereas, both American industrial development and our people generally have greatly benefited by the products of American inventive genius."

There cannot be many who do not subscribe to these truths. But there may be many, and evidently there are those in positions of authority, who fail to realize certain very pertinent truths. American inventive genius, without adequate incentive would be sterile; American inventive genius without industrial enterprise would be stillborn. Both cooperate to effect industrial advancement only because there is the prospect, in the event of success, of adequate recompense commensurate with the effort made and the risk taken; recompense in the ultimate end of industrial advancement—greater wealth. The patent system now provides that prospect. No other system has, as yet, been suggested that has that same prospect in so great a measure or with so little expense to the government and the people.

An executive of one of America's largest corporations, mindful of the impetus given to business by patents, recently suggested to the writer that the patent system ought to be extended to include the grant of patents for reviving dormant industries. This suggestion is not inconsistent with the fundamental purpose of patents. To some extent, at least, the germ of a like idea may be found in the patent laws of England. In that country, any patent or publication that is more than 50 years old is not considered as pertinent prior art or knowledge in considering an application for patent. Thus, inferentially, it is recognized that it may be beneficial, through the patent system, to encourage the utilization of old, forgotten ideas, and so perhaps revivify old industries.

Patent System Attacked

Yet, during the last decade, there has been a consistent attack upon patents for inventions culminating in the recent adverse publicity, and in many instances unjust criticism of the part played by patents in agreements between American and German concerns. These critics lose sight of the fact that Germans, as well as Englishmen and others of foreign countries give to America knowledge of their development work only because of the patent system through which they may be recompensed for so doing. They lose sight of the fact that large, wealthy corporations can afford to pour large sums into consistent development work that benefits the entire

nation only because the patent system gives them hope of regaining their investments in the event of success. They lose sight of the fact that it is only by virtue of the agreements with the German concerns, made possible by the inducement to the Germans offered by our patent system, that we obtained the germ of the ideas for tungsten carbide tool steel, artificial rubber, and many other important products.

But the criticism has been severe and the pressure intense. It has found expression heretofore in the antagonistic attitude the courts have taken with respect to patents. It is being expressed in congressional investigations and demands for changes in the patent law. Can it be these loud voices that lash industry and attack the fructifying stimulant of industrial progress are the proverbial "red herring" drawn across the trail to divert attention from political blunders? Is it that America now suffers a rubber shortage because there are patents on the production of artificial rubber, which never could compete with natural rubber, and agreements relating to them, or is it because the rubber countries have been lost to the Allied Nations and an adequate supply of natural rubber, in anticipation of that loss, was not imported or developed in the rubber producing countries of South America?

Or is there a deeper significance in the present severe attack upon the patent system? Does it form a step in a plan for socialization of industrial research and development with ultimate governmental control over industry? Whether those who lead this attack upon patents are conscious of this trend or not, it is, definitely, a possible result. And, increasingly, the public is asking itself and each other these questions. Although the attack upon patents and the investigation of the patent system is being made on the basis of correcting abuses, the form it has taken is such as to cause thinking men to question the sincerity of purpose and look for a deeper meaning.

There was nothing reprehensive about the agreements between American and German concerns prior to the time Germany became an enemy of this country. And, there was no need, once we were at war with Germany to attack such agreements. The government has and had the power to seize the German-held patents, and so control the use of the inventions as it saw fit. Are there not like agreements between American and English concerns? If, inherently, the agreements with concerns of a foreign country are reprehensible, they are alike reprehensible whether they are made with concerns of Germany or England. Why is additional power desired over patents held by domestic concerns? Without any additional legislation, the government can make use of any patented invention in whatever manner it sees fit in furtherance of the war effort. Why in seeking additional legislation for further and complete governmental control of patents are the facts distorted? The so-called Dzus patented "screw" is in reality a cowl fastener. The owner of the patent offered airplane producing companies a royalty free license to make these fasteners for their own use for the duration. Can it then be, as stated, that the patent holds up the production of airplanes? Again, the Dzus Cowl Fastener is not the only cowl fastener on the market or in use for the same purpose.

Abuses Minor

Undoubtedly, there are certain relatively minor abuses of the patent grant that, if corrected, might well be of benefit. But if this be the purpose of the attack upon the patent system, it should be so stated; the abuses described and the desired correction explained. The severity and consistency of the attack is such that it is as illogical for one to think that is the purpose as it is for one to think that a pile driver is used to drive a carpet tack. The effects of the uncertainty caused by failure to specify the purpose, and the severity of the attack, result in conclusions being drawn that have an adverse effect on invention and development. It is not unusual to hear considered opinions to the effect that patents may be disregarded and in consequence, invention and development are not worth while. The effects of short rations for the goose during the last decade are being felt. Just recently the Commissioner of Patents testified that, because of the unfavorable attitude towards patents, the number of applications for patent is falling off. The people are beginning to believe that the chance of making money through inventions and patents is too remote. It appears certain that unless reason reigns, and soon, the goose is gone.

Some indication may be had of the effect of destroying the inducement to the free exercise of creative genius from the attitude that exists with respect to inventions of a purely military character and for which the government is the only customer. To those who are acquainted with the conditions, there is little inducement to develop such inventions to the point of determining whether they are practicable or useful. For a patentee whose invention is used by the government, there is but one remedy. He may sue in the Court of Claims for reasonable compensation for the use by the government of his invention. Thus, if the government decides to purchase the patented product from one other than the patentee, the patentee has for his efforts only an expensive law suit, one that may not be finally determined for many years. As no government officer can settle a tort claim against the Government, there is no alternative but to sue if the right of compensation is to be determined.

In addition, some branches of the government impose conditions on a patentee who seeks to supply the government with his patented product that render the patent of little value. One such condition that is sometimes imposed as a part of a contract to buy the patented article is that the government be given a free license under the patent so that on subsequent orders it may disregard the patent and if the article is supplied by a competitor the patentee even loses his right to sue in the Court of Claims for a reasonable compensation. It must be obvious, therefore, if the device is such that the government is the sole user, the patentee must, on the first order, recoup his entire development expense plus whatever may be the reasonable value of the invention. This, of course, with the restrictions on permissible profits in certain items, is impossible. If the article has a commercial market, the patentee's course is to avoid government orders if the condition is to be exacted.

The result is that there exists among those acquainted with the situation, a lack of interest in developing products that are used exclusively by the government. It may be true, particularly in time of war, that individuals who do conceive of what they think may be useful military implements, may write a description of them and send the description to the government. This is done to avoid the development expense and in the hope that if they be found useful, the individual will receive proper compensation. But such, other than in extraordinary cases, perhaps are of little use. What the government needs is not suggestions on paper, but practical working embodiments of the invention, something tangible that can be tried and tested under the conditions it is to operate. We are all familiar with the controversy that was waged over the relative merits of the Garand automatic rifle as compared with the Springfield rifle. This was with the rifles available for comparative tests. The Garand was finally accepted. Imagine the chance it would have had, if only sketches of it had been submitted.

Must Depend on Individuals

The government is in no position to peruse, much less originate, all the suggestions made. Even an inconceivably large staff of research workers would not be sufficient to develop all ideas to a point where comparative tests of work-

ing embodiments might be made. Given the proper incentive, the individuals who conceive the ideas will by themselves, or with backing, do this very thing. The very fact that time, labor, and private capital are to be expended on the chance that the device will be successful is sufficient to insure a weeding out of the deadwood in the beginning, and the provision of adequate reward in the event of success will insure a fair chance for those of any promise. Additionally, there will be many units operating simultaneously on different ideas and not one as a government agency.

If the incentive afforded by the patent system be rendered impotent or destroyed, there can be but one result—industrial research by the government. Such a system must be enormously wasteful to be productive. It is rare indeed that anyone can determine whether a proposed machine or product will operate or can ever be made to operate successfully for the purpose intended. In consequence, if the promotion of an individual is determined by the success of such prognostications, the safest policy for such an individual to pursue is when in doubt, do nothing. If this be not the criterion for advancement, then every fantastic idea forms the basis for a research project.

It is high time, and it should not be the too familiar cry of "too little, too late," for American industry to bring out the facts and lay them, clearly, before the American people. Let them see the forest and the trees, what they have and what they may get. The subject is too important to every individual and to the nation to be longer ignored by the general public. The people should and must be informed to avert hasty, ill-considered action. To this end, industry should make a united effort to bring the subject before the public in its true light. No unjust criticism of any industry or of any unit of any industry should be permitted to pass unchallenged. A constructive policy of public education should be undertaken.

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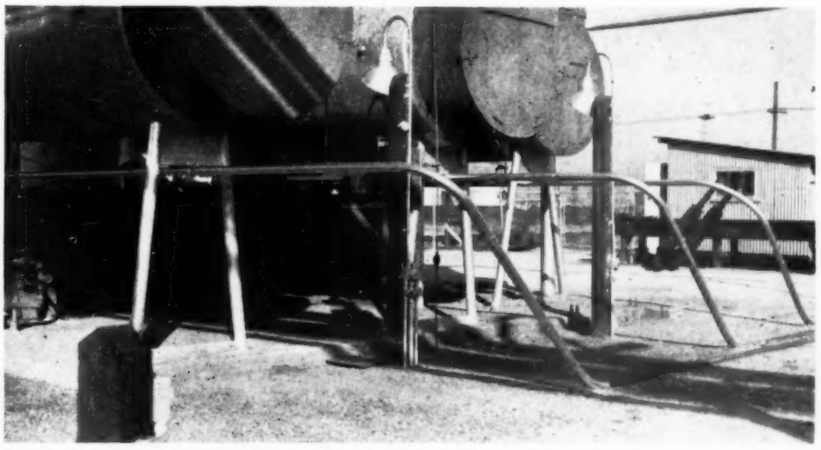
P 762.1
P 422.335

Installing Boiler Blow-down Receiver and Piping

by J. C. Albright

WHEN boilers are employed for permanent or semi-permanent operation in a compressor plant, pump station, or on a drilling operation, the premises can be kept neat appearing by employing a definite layout system. To provide sufficient space beneath the boilers for adequate policing of the grounds, which may or may not be covered with chat or gravel, supports are provided for the stack end by using lengths of the most convenient size of pipe joined at the top with a short I-beam section solidly welded to the supporting pipes. The top side of the I-beam is cut to conform to the arc of the boiler for a snug and continuous contact. The supporting posts may be set in a concrete grouted hole to add stability to the boiler setting. To prevent frayed insulation on light wires, the cables are placed in underground conduits with lamp standards and goosenecks placed so that maximum illumination may be obtained.

For blow-down facilities, each boiler may be equipped with standard blow-down valves and piping laid beneath the waist and running to the stack end, supported on hangers attached to the I-beam sections, which are welded to the top of the supporting posts. The hangers for the blow-down piping may be made by using the most convenient U-bolt obtainable, attached to holes drilled in the flange of the I-beam section. In the accompanying illustration of the boiler setting, the blow-down pipes extend clear of the boiler area and lead to the ground by long bends, where they are laid in shallow trenches and covered with a layer of chat or gravel. At a distance from the boilers, determined by available space and other obvious factors, a blow-down receiver is situated that provides a factor of safety when blowing down the boilers at regular intervals for the removal of sludge accumulating in the mud ring.



Boilers installed in compressor station with blow-down lines extending backward for easy bends to blow-down receiver

A short, heavy cylindrical tank has its advantages as a blow-down receiver. Each end may be closed with light sheets of steel, which may be stiffened with a cross angle of iron welded to the sheets to prevent vibration and drumming when blowing down the boilers. Supporting lugs may be welded or riveted to the sides of the drum to carry the load when the unit is set horizontally on concrete cradles. A short nipple of 8- or 10-in. pipe is welded to the upper horizontal center of the drum and is fitted with a bolted flange for attaching the vapor stack, which elevates the steam and water vapor to a safe height overhead. Draining the drum may be accomplished by a bull-plug closed collar welded to the lower part of the light drumhead, or a gate valve may be installed if more convenient.

Connections for the individual boiler blow-down piping are made near the top of the drum through tangentially welded nipples having threaded ends for attaching connecting piping with lip or bolted unions. The connecting nozzles attached to the blow-down receiver at a tangent give the blow-down water, steam, and sludge a centrifugal motion inside the drum for effective separation so that a minimum quantity of blow-down will be vented to the air as vapor. The bulk of the water and the sludge remains in the receiver so that it may be drained to adequate disposal pits.

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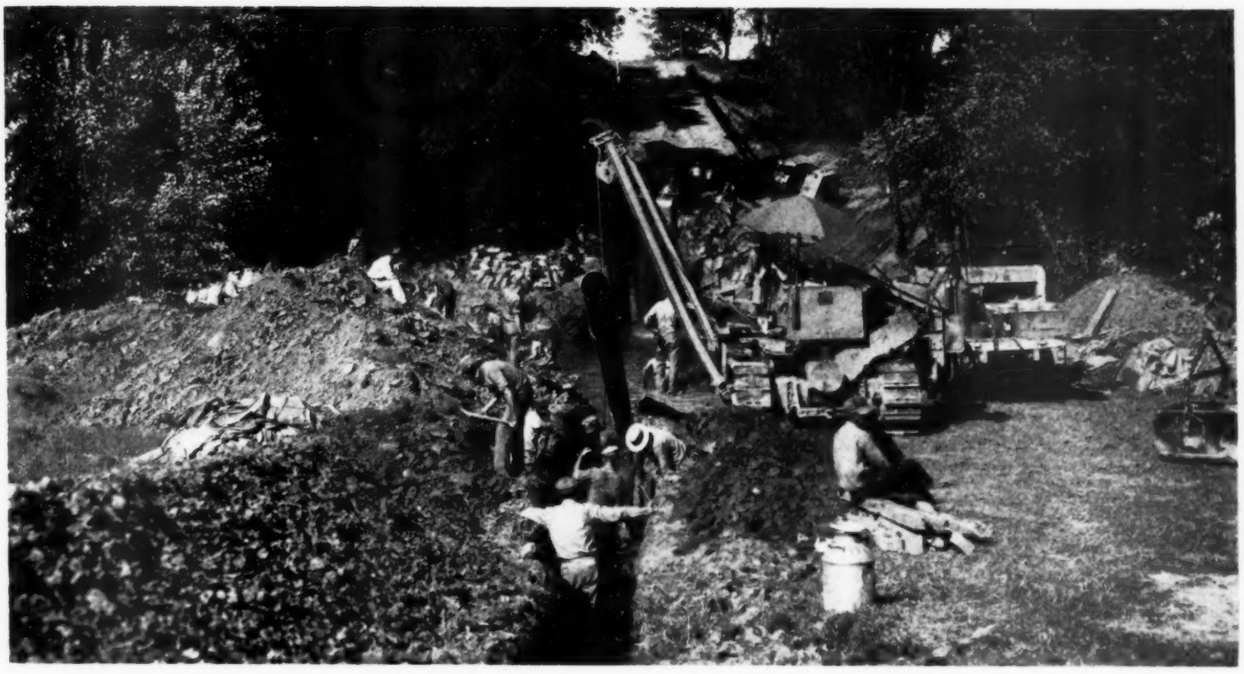
WORLD'S LARGEST EXCLUSIVE OIL WELL PUMP MANUFACTURER



Lowering section of pipe in Tiger Creek. This creek was crossed 26 times in 20 miles

Pipe Line Laid Through Rough Terrain of West Virginia

PETROLEUM ENGINEER Exclusive Feature

☆ **Excellent construction time made with heavy equipment despite numerous difficulties**

by Frank H. Love
Managing Editor

RECENTLY a 14-¾n. gas line was laid for the Anchor Hocking Glass Company through the rocky, hilly area of West Virginia. This work is of particular interest because of the nature of the terrain, the several rivers and many creeks crossed, as well as the fact that for the first time heavy pipe-line construction equipment was used to lay a line through this section of the state. Previous lines had been laid principally by manual labor.

The line originates in the field recently discovered by the Columbian Carbon Company at Sandyville, West Virginia, and extends to a point near Marietta, Ohio, known as Gravel Bank. Here it ties into the Ohio Fuel Company's line, which transports the gas to the Anchor Hocking Glass Company's plant at Lancaster, Ohio.

In constructing the line the contractor, Jones and Brooks of Oklahoma City, Oklahoma, followed the ridges, or what in the parlance of the section are known as "hog backs," for about one-half the line's total distance; the other half of the right-of-way wound through the valleys. The valley route was chosen for a part of the line in the belief that better construction progress could be made. The wisdom of this move later became questionable, as by so doing it became necessary to make numerous crossings of Tiger Creek, 26 such crossings being required in a distance of 20 miles. The width of these crossings varied from 40 to 60 ft. and their depth from 8 to 14 ft. It was essential to construct bridges at each crossing for the movement of equipment, and to make a cut in both banks to a depth of 15 to 17 ft. in order to place the drips at the proper depth, one drip being installed at each crossing. At 20-ft. intervals, 600-lb. river clamps were installed, and to avoid the possibility of the creek changing its course and following the pipe-line trench, all approaches were rip-rapped. The fact that 72,000 sacks were required for rip-rapping indicates the enormity of this one operation.

Pipe Reconditioned

As a part of the general program to conserve steel, the line pipe used consisted of pipe taken up in Pennsylvania and transported to Parkersburg, West Virginia, where it was reconditioned. The pipe was of high carbon steel that had been in the ground for a period of approximately five years. The high carbon content of the steel made it impossible to bend the pipe cold as is customary for this size pipe, consequently wrinkle bends were employed.

As mentioned, the basic idea insofar as equipment was concerned was to use heavy equipment and in sufficient amounts to assure a satisfactory and a rapid laying job. In clearing the right-of-way three RD-7 bulldozers were used whereas ordinarily but one is employed. Two heavy ditchers cut the greater part of the trench; when rocky areas were encountered on the ridges

View showing type of right-of-way made; also rocky and hilly nature of the country

two trench hoes were used to remove the rock after it had been broken-up by air-drills or blasting. On some of the hills the ditching machines were aided by winch trucks to enable them to climb the steep grades. Other principal equipment consisted of two R-5 sideboom tractors for bending, two R-5's for lining-up the pipe for the tack welders, one R-5 for lowering-in, one backfiller, one RD-7 angledozer for cleaning-up after the line was covered, and ten electric welding machines.

For the most part welding was by the stove-pipe method, although roll-welding was employed when it was deemed advantageous. Due to the roughness of the country and size of the pipe, and because otherwise joints might become strained, the tack welders ran the stringer bead as well as making the tack welds. This gave the joints sufficient strength to prevent damage before the finish beads were made. In all, three beads were run.

Limestone Mountain

The crossing of Limestone Mountain presented a particularly difficult construction problem. Five different ledges, each almost vertical for a distance of about 400 ft., were encountered. The method of procedure here was to shoot off the ledges working from the top downward. The pipe then was worked down from the top except for perhaps 500 ft., which was worked up from the bottom after the right-of-way had been made. To make ditch through this rocky area, the rock was first air-drilled or shot and the ditch dug with a trench hoe, again working from the top downward.

River Crossings

The two rivers crossed by the line were the Ohio and the Little Kanawa, the width of the former being 2200 ft. including approaches, and the latter 1000 ft. Dual 12-in. lines were laid across the Ohio River and dual 14-in. lines across the Little Kanawa.

The Ohio River crossing was laid

Welding a joint of pipe. For the most part welding was by the "stove-pipe" method

with the aid of three barges, two derrick boats, and one cutter-head dredge. The pipe was welded on the bank into three-joint sections and carried down ramps by winch tractors to the water's edge. A derrick boat then picked-up the sections and loaded them on the supply barges. Two of the three barges were used as supply barges and the sections were welded together on the deck of the third. After a joint was welded on this barge, a derrick boat lifted the pipe off the deck of the barge and suspended it there while a tug pushed the barge from beneath the pipe. When the pipe was thus lowered into the river another joint was welded to the end held by the barge and the procedure repeated. At the end of each day's work a swab was run through the pipe to determine any buckled joints that might have occurred in lowering. As the river is a navigable stream, it was necessary to bury the lines 3 ft. below the river bed. The trenches were dug by the cutter-head dredge and the two ditches spaced 14 ft. apart. Both lines were allowed 600 ft. of slack upstream.

Because the banks of the Ohio River were rocky, approximately 650 ft. on each of the dual lines had to be string-shot, the broken rock then being removed by a dipper dredge.

As the Little Kanawa River was not so wide as the Ohio, a somewhat different method was employed to lay this crossing. The sections were welded on the banks of the river and floated into the stream supported by pontoons and pulled by winch tractors. The pipe was worked from both banks simultaneously and the final weld made and the final river clamp installed on a derrick boat in midstream. The Little Kanawa River also is navigable and in this instance it was required that the line be 4 ft. beneath the bed of the river. It was not necessary, however, to provide as much slack upstream as in the case of the Ohio River, consequently only 200 ft. was allowed.

On both river crossings 600-lb. river clamps were placed on the pipe at intervals of 20 ft. Also at each river headers, gate valves, and drips were installed.

Despite the many difficulties encountered, it was found that with the methods of construction adopted and by using heavy pipe-line equipment, approximately 2500 ft. of pipe was laid a day. This exceeds by about 1500 ft. a day the laying time made previously through parts of West Virginia presenting similar conditions.

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Making a crossing of the Little Kanawa River

High carbon content of the line pipe made it necessary to "wrinkle-bend" the pipe

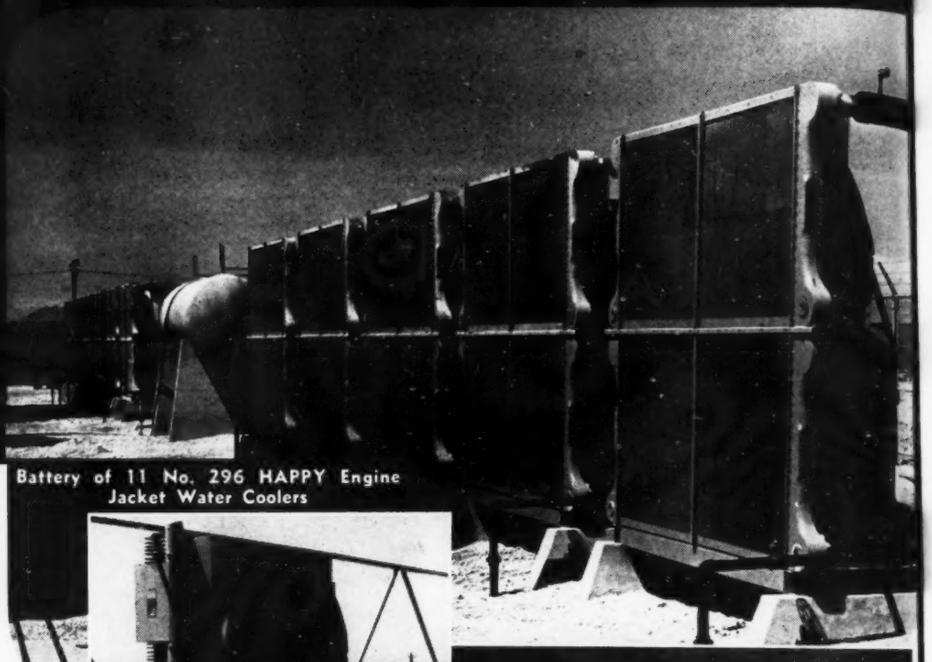
SAVED STEEL ON FORTY MILE WATER PIPE LINE

Happy

AIR-COOLED JACKET WATER
AND
AIR-COOLED GAS

Coolers

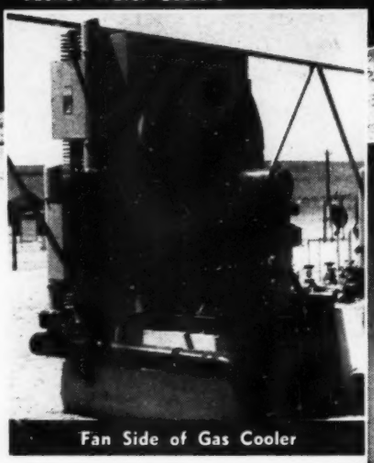
AFTER PRELIMINARY TESTS
PROVE ECONOMICAL



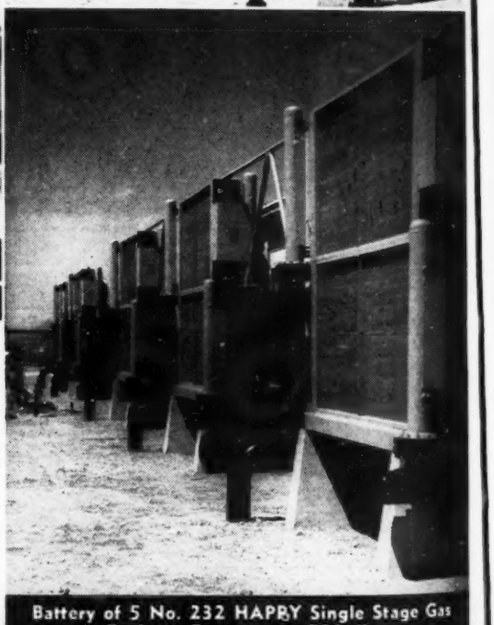
Battery of 11 No. 296 HAPPY Engine Jacket Water Coolers

At Compressor Station No. 2, The El Paso Natural Gas Company was faced with the problem of constructing a 40-mile water pipe line to obtain 60,000 to 100,000 gallons of water per day for cooling six 800-hp. Cooper-Bessemer Type 19 twin-tandem double-acting horizontal gas-engine compressor units, plus 400-hp. of auxiliary engines.

A battery of eleven No. 296 HAPPY Engine Jacket Water Coolers and a battery of five No. 232 HAPPY Single Stage Gas Coolers were installed. This eliminated the need for the pipe line, as the HAPPY Jacket Coolers required only a nominal amount of water per day for make-up. This installation is the first large-scale cooling of natural gas by air on a large gas pipe line.



Fan Side of Gas Cooler



Battery of 5 No. 232 HAPPY Single Stage Gas Coolers. Capacity at 500 lbs. Working Pressure

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The years of experience and study our engineers have given to cooling problems has led our customers to look to us for recommendations. There's no obligation in calling on us. Write The Happy Company, Main Office, 310 East 10th Street, Tulsa, Oklahoma. Branch Offices: Seminole, Okla.; Wichita, Kans.; Ellinwood, Kans.; Salen, Ill.; Fort Worth, Texas; Odessa, Texas; Pampa, Texas; Wichita Falls, Texas; Kilgore, Texas; El Dorado, Arkansas.

HAPPY CHASES HEAT

Minimum Water—Exact Temperature Control — Scale Elimination — Lower Maintenance Costs

The Happy Company
TULSA, OKLAHOMA

P 620.
P 624.5

Compressor Station Equipped with Radiator Cooling System

PETROLEUM ENGINEER Exclusive Feature

☆ Tests determine practicability of method in area where water shortage exists

by C. L. Moore

Assistant Superintendent Compressor Stations, El Paso Natural Gas Company

THE El Paso Natural Gas Company has recently equipped one of its compressor stations with a radiator cooling system for both its engine and gas-cooling requirements. This station consists of six 800-hp., twin-tandem horizontal gas-engine-driven compressors and prior to the installation of this radiator method of cooling, used from 60,000 to 70,000 gal. of treated water per day and during the windy spring months as high as 100,000 gal. per day.

Tests Made

The scarcity of water in this area necessitated either the construction of a 40-mile water pipe line or a different method of cooling. The installation of the radiator system was made after exhaustive tests on one of the 800-hp. units at this station. This initial test equipment consisted of two large 8-ft. by 8-ft. vertical radiator sections, each being equipped with 93-in. variable pitch fans, V-belt driven by a small gas engine. The piping to the radiators was so arranged that the radiators could be used either in parallel or in series, which gave the flexibility required for the test. During the test, data were acquired to determine the most desirable engine operating temperatures from a standpoint of engine maintenance as well as operating costs on the radiator equipment. The maximum jacket water inlet temperature was found to be 140°F. with an outlet temperature of 150°F., and a 140°F. engine inlet temperature produced a temperature of approximately 160°F. on the water-cooled power piston rod outlet; all temperatures being with an air temperature of 100°F.

The engine on which the tests were being run was kept fully loaded at all times and gave no indication of any mechanical troubles by reason of the higher jacket temperatures. The water circulation rate was doubled, however, in order to obtain the desired temperature differences.

C. L. MOORE

graduated from the University of Texas in 1935 with a bachelor of science degree in mechanical engineering—Has been employed by the El Paso Natural Gas Company for the last seven years and is now assistant superintendent of compressor stations.

One of the numerous difficulties encountered in cooling this type of engine was the splashing of water into the lubricating oil from the water-cooled piston and rod. It was a simple matter to completely close the water circulation through the jackets, but with the additional quantity of water flowing through the rod the problem was somewhat more difficult. The built-in drains of the engine were insufficient adequately to carry the cooling water away, thus causing an accumulation of water in the bearing lubricating oil. This problem was solved after sufficient test data had been accumulated to determine the practicability of the use of radiators.

From the original tests the conclusion was drawn that if the abovementioned temperatures were not exceeded, the engine performance would not be affected so far as ring and packing clearances were concerned, and also it was not considered necessary to change the characteristics of the cylinder lubricant heretofore used.

Equipment Installed

Based on the test data acquired, a total of 11 radiators of the size and

Fig. 1. Constant-speed motor driving fan on radiator for engine jacket water cooling

capacity as above were selected and installed for engine jacket water cooling. The fans for such radiators were direct-connected to constant-speed motors; the flexibility required being obtained from the variable pitch of the fan blades rather than from variable-speed motors. Such radiators were connected in parallel as shown in Fig 2. and designed to receive water during maximum conditions at 153°F. inlet temperature and 140°F. outlet temperature. Three circulating water pumps were connected so as to receive their suction from the radiator battery and pump directly to the engines and from there back to the radiators. The engine rod water drains from the engine at atmospheric pressure to a separate header and is pumped from there by one low-head pump directly to the inlet of the water head serving the radiator battery. As this arrangement is a dual system, the operation required a float valve assembly so arranged that the two-pump system can be balanced without undue manipulation.

In addition to cooling the engine jacket water, it was necessary to run tests and select equipment suitable for cooling the gas after compression. In the past this was accomplished by shell-and-tube heat exchangers, using the engine jacket water as a cooling medium. In using radiator cooling, it was found to be impossible to obtain proper gas cooling due to the increased outlet temperature of the engine jacket water. Tests were first run in an effort to use the shell-and-tube heat exchangers in connection with water radiators; the method used being to increase the amount of water circulation through the shell-and-tube exchangers sufficiently to lower the gas temperature, but this method was unsatisfactory due to the low efficiency in cooling water through the radiators by means of air. It was finally decided to use direct air-to-gas exchangers such as are shown in Fig. 3. This equipment is in effect a gas radiator using small bronze tubes finned as cooling surfaces, and being of sufficient strength to operate at 500 lb. per sq. in. Five such gas radiators were selected and installed in parallel between the compressor transfer header and the main discharge header as shown in Fig. 4. These radiators were designed to cool the gas, after compression under maximum load conditions, to a temperature not to exceed 10°F. above atmospheric temperature and the pressure drop of the gas through the radiators not to exceed 7 lb. per sq. in.

The installation of the equipment was completed during the early part of March, 1942, and the station has been operating satisfactorily since that time, although maximum load conditions have not as yet occurred. At the present time it is believed that it will be necessary to install one additional gas-cooling unit.

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Fig. 4. Radiators for cooling gas installed in parallel between compressor transfer header and main discharge header

Fig. 2. Eleven radiators were installed for engine jacket water cooling

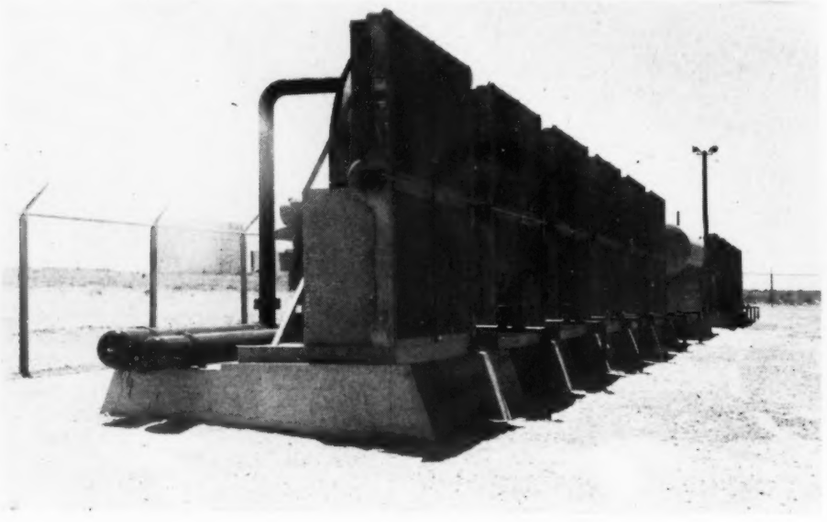
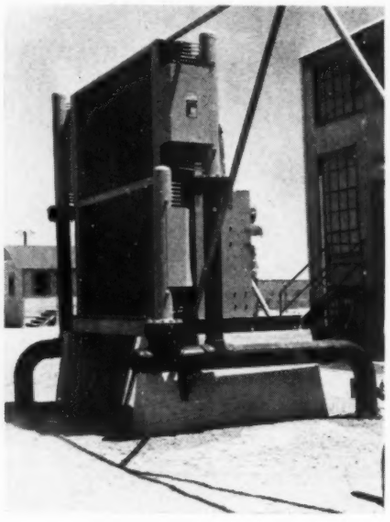


Fig. 3. Direct air-to-gas exchangers



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Oil-Well Cementing*

☆ Problems encountered and methods adopted to obtain satisfactory bond between oil string and formation

by J. V. Polk
Independent Operator

THE cementing of oil wells, especially the cementing of oil strings, presents one of the most interesting and at the same time one of the most difficult problems with which the petroleum engineer has to deal. The problem involved is to insure the best bond possible between the oil string and the formation through the medium of set cement. In oil-well cementing operations, failures to obtain satisfactory results are usually ascribed to channeling of the cement slurry, off-centered casing, and the presence of a residual mud cake between the set cement and the formation.

Experiments have been conducted and were presented at the spring meeting of the Pacific Coast District of the American Petroleum Institute in 1940 by Jones and Berdine[1] of California, to determine factors influencing the bond between set cement and the formation. These experiments, involving 42 test wells, were conducted by simulating, as nearly as possible, actual well conditions. Various muds, cement slurries, pumping procedures, wall-scraping devices, different types of cementing shoes, centering devices, operating practices such as movement of casing while cementing, different velocities, etc., were studied.

Channeling of cement slurries. Experiments such as those conducted by Jones and Berdine show conclusively that cement slurries do channel, but not nearly so much in the immediate region of the cement shoe as near the top of the cement column. Aids to prevent or minimize channeling are:

(1) Proper conditioning of drilling mud, with stress on maintaining the viscosity at a minimum.

(2) Having bore hole as nearly vertical as possible to prevent off-centered casing; also the use of whirler shoes, centering devices, etc.

*This paper was presented at a meeting of the Petroleum Industries Association, a group of company engineers and others in the general vicinity of Corpus Christi, Texas, who are interested in studying some of the many drilling and production problems encountered in this strategic area.

[1]"*Oil Well Cementing; Factors Influencing Bond Between Cement and Formation*," by P. H. Jones and Denis Berdine. Presented at the A.P.I. Division of Production, Pacific Coast District, Los Angeles, California, March 19, 1940. Reprinted in *Drilling and Production Practice*, 1940.

THE AUTHOR

J. V. Polk was with the Coronado Corporation from the time it was organized January 1, 1939, until November, 1941, when the company's stock was sold to the Standard Oil Company—At that time he was production superintendent and made his headquarters at Woodsboro, Texas—Before joining the staff of the Coronado Corporation he was with Geophysical Service, Inc., Dallas, Texas, for about 10 years—He is now an independent operator.

Residual mud cake. The presence of a mud cake between set cement and the formation presents the greatest problem in oil-well completion. The well may behave perfectly at the time of completion, yet this mud cake constitutes a region of weakness that will break down or shrink, thereby providing a channel for the migration of water past the cement seal. If this mud cake gave way in an oil sand that has a gas cap, it would probably cause the well to have a high gas-oil ratio. Actual instances are known of wells that produced no water and had a low gas-oil ratio at time of completion that later had a high gas-oil ratio and produced 15 percent water.

Experiments by Jones and Berdine[1] indicate three methods to be most effective in removing the mud cake at the time of cementing the oil string:

(1) Hydraulic action by direct impingement of fluid jets (such as whirler shoes) against the walls of the hole.

(2) Mechanical scraping devices attached to the casing, and alternately raising and lowering the casing through the producing zone.

(3) Acid treatment.

When cement is applied opposite a formation having appreciable permeability, a residual mud cake will remain between the set cement and formation unless some method is employed to effect its removal.

Squeeze Cementing

Despite all precautions taken in drilling and completing a well, there is always doubt regarding whether a perfect bond has been obtained between the set cement and the formation. Failures to obtain a good bond are ascribed to cavities in the producing zone, channeling of cement slurries, egg-shaped hole, off-centered casing, mud cake, etc. Whether squeeze cementing offers a definite solution depends principally on the following:

1. Proper placement of shots with respect to gas-oil and oil-water contacts.

2. Pressure attained at close of squeeze job.

It is believed highly important that shots be placed as near the zones of trouble as possible, such as gas-oil and water-oil contact, so that these areas will derive the greatest benefit.

TABLE I

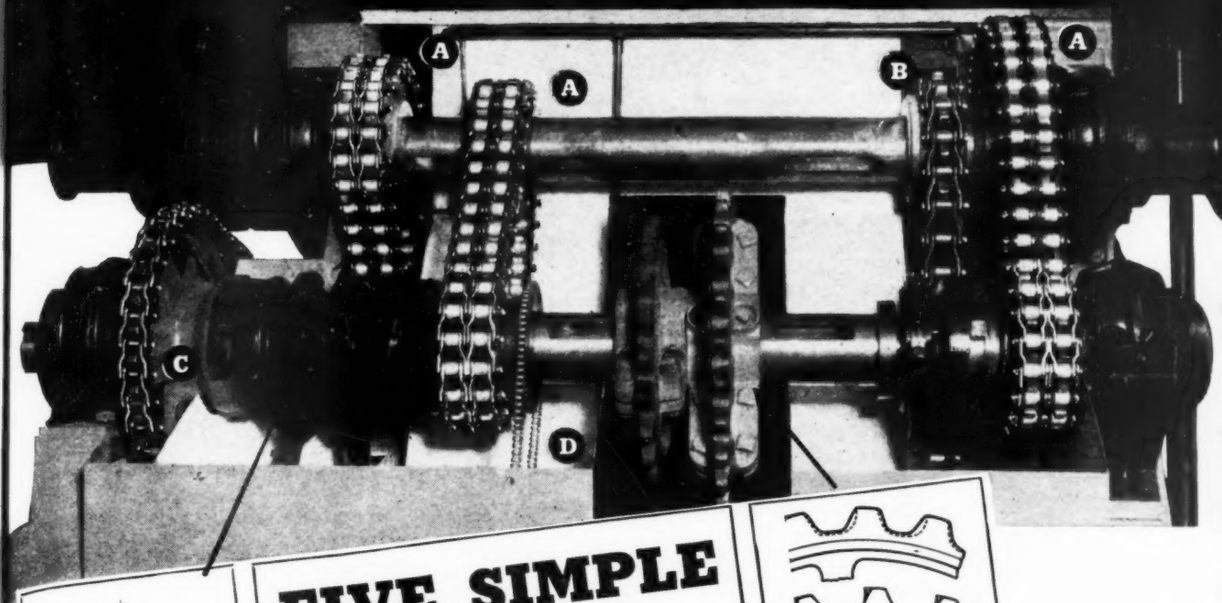
Record of a successful squeeze job on well "A" in the La Rosa Field, Refugio County, Texas

Perforated section: 5410-13 ft. (12 shots); 5420-23 ft. (12 shots).
Bullets fired through casing: 24.
Contents of sand: oil and gas.
Cementing equipment: drillable retainer.
Initial breakdown pressure: 2100 lb. per sq. in.
Type of cement used: slow-set, heat-resisting.
Average weight of slurry: 16 lb. per gal.
Quantity of cement used: 100 sacks.

Elapsed time after beginning squeeze job, minutes	Time allowed for slurry to thicken between stages, minutes	Volume slurry pumped-in, sacks	Pressure with pump stopped, lb. per sq. in.
10	..	50	1430
20	5	65	2180
35	5	75	2500
48	3	85	3300

Backwashed 3 bbl. cement.
Maximum pressure: 3300 lb. per sq. in.
Results of squeeze job after perforating 5416-19 ft. and completing well: low gas-oil ratio and no water.

HOW TO MAKE CHAIN DRIVES LAST LONGER



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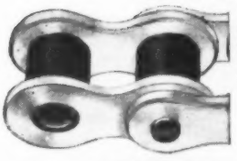
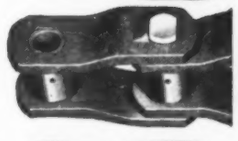


API-3 Red-Hed Rotary Chain. 50,000 lbs. ult. strength.



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API-4 Super Hyper Precision Rotary Chain. 175,000 lbs. ult. strength.

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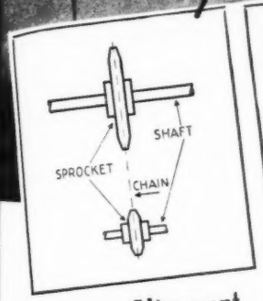
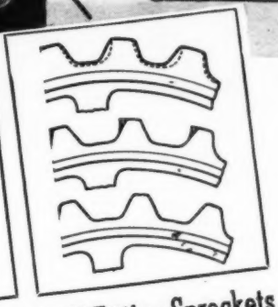


FIVE SIMPLE THINGS TO DO . . .



Proper Alignment

Be sure that sprocket wheels are lined up on the shafts. If sprockets are not exactly in line, a side pull develops which concentrates the load on the sides of the sprocket teeth, and on one side of the chain. This faulty alignment results in excessive wear on both chains and sprockets.

Proper Adjustment

Chain should be run with just a little more slack than a belt. Too much tension causes undue wear on the chain and wasteful friction on the bearings. Not enough tension may allow the chain to jump the sprocket or ride the teeth, causing breakage.

Proper Lubrication

A forced-feed type lubrication system employing a small rotary type pump driven from a jack shaft of drawworks is ideal. A drip system is employed on a large number of rigs, and we suggest that oil should drip on the chain on inside (upper side of lower run) while chain is in operation. A good grade of lubricant should be used, viscosity to be determined by climatic conditions. Under no circumstances should drained oil from Diesel, gasoline or steam engines be re-used to lubricate chains. This oil is not capable of withstanding extreme high pressure bearing loads.

Well-Fitting Sprockets

Check sprocket wheels regularly to make sure they are not worn enough to damage chain. Wear (shown by dotted lines) that results in the hook (shown by shaded area) on driving side of sprocket can be removed by grinding the tooth. This will result in smoother chain action between chain and sprocket. If teeth are too badly worn, wheels should be replaced with accurately made and close fitting sprockets. Machine cut tooth sprockets are recommended; however, the above procedure may be followed for present day conditions where cast tooth sprockets are employed.

Post these suggestions in your tool house!

CLEANING . . . If rig is racked for a period of six months or more, chain should be removed from sprockets, thoroughly cleaned with gasoline, re-oiled and stored in a dust-proof compartment. When chain is again put back in service, it should be first cleaned and re-oiled.

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Various experiments have shown conclusively that a successful squeeze job depends on the pressure attained at the close of the job. The higher the pressure that can be applied to the cement slurry, within limits set by the conditions of each specific well, the better and more lasting the cement job will be.

In the original A.P.I. study[2] it was shown that maximum surface squeeze pressure of approximately 4000 lb. per sq. in. was essential for effective example, conditions such as a formation with very low permeability in which the sedimentary weakness and bedding planes may be depended on as a source of production.

Squeeze pressures that produce a rupture in the sand, causing thin laminations of cement along the bedding planes, may be highly beneficial in sand having appreciable permeability, inasmuch as these laminations may retard the coning effect caused by the flow of fluid from the sand.

TABLE 2

Record of successful squeeze job on well "B" in the La Rosa Field, Refugio County, Texas

Perforated section: 6330-32 ft. (12 shots); 6342-44 ft. (12 shots).
Bullets fired through casing: 24.
Contents of sand: 6314-20 ft. gas; 6320-45 ft. oil; 6345- salt water.
Cementing equipment: Open-ended tubing.
Initial break-down pressure: 1800 lb. per sq. in.
Type of cement used: slow-set, heat-resisting.
Average weight of slurry: 16 lb. per gal.
Cement used: 100 sacks.

Elapsed time after beginning squeeze job, minutes	Time allowed for slurry to thicken between stages, minutes	Volume slurry pumped-in, sacks	Pressure with pump stopped, lb. per sq. in.
5	-	40	975
15	5	55	1450
24	4	65	1700
40	3	80	3500

Backwashed 2½ bbl. cement.
Maximum pressure: 3500 lb. per sq. in.
Results of squeeze job after perforating 6334-37 ft. and completing well: low gas-oil ratio, no water.

clusion of water, and that maximum surface pressure of approximately 3000 lb. per sq. in. was essential for the reduction of gas-oil ratios. Engineers with one manufacturing company have suggested the following formula to calculate the maximum surface pressure desired for a specific job:

Pressure to be applied equals 40 percent of the depth of the horizon to be squeezed, plus 1000 lb. per sq. in.

Some variation in this formula is proposed, in that 500 lb. per sq. in. additional pressure may be desirable for water shut-off jobs, and 500 lb. per sq. in. less pressure may be satisfactory for the reduction of gas-oil ratios.

Geological and engineering data have been presented[2] to show that squeeze cementing actually effects a rupture of the formation to which the squeeze pressure is applied, the fracture occurring along lines of inherent weakness or sedimentary bedding planes. Further confirmation of this phenomenon has been observed in cores of sand formations in sidetracked holes that have been previously squeezed. These cores show that the cement slurry sets as relatively thin laminations between the individual bedding planes in the sand body.

Inasmuch as very little is known concerning the effect excessive pressures have on different individual sand conditions, care should be exercised due to the varying permeability of sands. For

[2] "*Selective Exclusion of Fluids from Oil Wells*," by Paul D. Torrey. Presented at the A.P.I. meeting, New Orleans, Louisiana, May 18, 1939. Reprinted in *Drilling and Production Practice*, 1939.

Squeeze-Cementing Methods

Squeezing with open-ended tubing. The earliest method of squeezing cement slurry in oil and gas wells was to place the slurry through the tubing, with the bottom of the tubing near the place to be squeezed, then to raise the tubing to a safe distance above the slurry, and by means of pump pressure force the slurry into the formation. This procedure was found to be unsatisfactory because much time was required to complete the operation of placing the cement and pulling tubing up the required distance. During this time the slurry would have thickened, making it more difficult to pump.

A better method of squeezing with open-ended tubing is to place the tubing 10 to 15 ft. above the place to be squeezed, then close the rams on the blowout preventer, using the fill-up valve below the preventer to establish circulation. After the formation has been washed with water, the mud or water is displaced with the cement slurry. As soon as the desired amount of cement is pumped into the tubing the valve on the fill-up line can be closed and the squeeze put on the formation without having to stop the pumps. After the squeeze job has been completed, the pressure is released on the tubing and the pumping connections changed from tubing to casing; then by pumping into the casing and back-washing the need for moving the tubing is eliminated. Application of this method of squeezing is limited, depending on the strength of the casing and its ability to withstand the pressure applied.

Squeezing with cement retainer. The cement retainer consists essentially of a rubber packing with a back-pressure valve at the bottom, which is used to keep any pressure applied from being exerted in the casing annulus and to hold pressure on the formation after the squeeze job is completed. The cement retainer is run into the well on a circulation joint, which in turn is connected directly to the tubing or drill pipe. The retainer is made of drillable material and is connected to the circulation joint by means of left-handed, square threads. The circulation joint provides a means of bleeding-off the tubing, and of removing the tubing after the job is completed.

The cement retainer provides much greater flexibility of operation than was formerly possible. Multiple batch jobs can be done with one setting of the cement retainer; also, any high pressure desired is possible without the risk of rupturing the casing. Where extremely high pressures are desired, care should be taken not to collapse the casing above the retainer. In cases where pressures of 4000 to 5000 lb. are necessary at depths less than 6000 ft., 1500-2000-lb. pressure can be applied between the tubing and casing and above the retainer. This is a safety factor to prevent the collapse of the casing immediately above the retainer.

Squeeze Technique

Squeezing in wells where thief sands, channeling, mud cakes, or other conditions cause the well to "take" the cement slurry under little or no pressure, more than one application of cement is nearly always necessary in order to effect a shutoff, or to attain the pressure desired. Experience has shown that the most effective way is to pump a certain quantity of cement into the formation, allow it to obtain at least a partial set, and then pump in more cement allowing each succeeding batch to block-off more channels until all are closed with cement, which at the end of the job will be "put away" under the desired pressure. This type of operation is known as "multiple batch" cementing. The multiple batch method of cementing is made possible by using the cement retainer with its circulation joint, which provides for the placement of any number of batches of the slurry in one extended operation in which only one cementing hook-up is used, and only one complete shut-down is necessary to allow the cement to reach its final set before drilling out.

Very little is known of the thickening time of cement after it has been

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pumped behind the pipe and is in contact with the formation. Experiments have shown that even slow-set premium oil-well cements will thicken in a few minutes after coming into contact with the formation, especially in squeeze jobs in which the slurry is spread out in a thin layer, such as small channels or where the cement is displacing the mud cake. This phenomenon may result from the cement losing its free water, much in the same manner as drilling mud loses its water to the formation to form the mud cake. The rate at which the cement slurry will lose its free water depends on the permeability of the formation, temperature, pressure, etc. This is substantiated by results of actual squeeze jobs such as presented in Tables 1 and 2, which indicate that the cement slurry does thicken during the shut-down period, that when pumping is resumed the slurry will break out in a different place. This process may be continued, allowing each succeeding batch to block-off more channels until all are closed with cement, and toward the end of the job the desired pressure can be obtained. As suggested by Tables 1 and 2, not less than 100 sacks of cement is required to do this type of squeeze job. This will allow at least five rest periods of 3 to 5 minutes between batches.

The Selection of Cement

The selection of cements specifically designed for squeezing, and the proper preparation of the slurry are most important. So far it has been impossible to develop apparatus that will indicate the exact length of time slurries can be pumped under the different conditions in the field. The fluidity meter, used by engineers of one cement manufacturer, was designed to give a factor of safety for the length of time the slurry can be expected to remain pumpable. The curves plotted, using the fluidity meter together with curves plotted using the Vicat needle, indicate that 16-lb. slurry at 200° F. temperature will remain pumpable approximately four hours. Field engineers may use any safety factor they believe is warranted. The writer is of the opinion that two hours provide a reasonable safety factor and believes that cement slurry should be cleaned from the pipe at intervals of not more than two hours.

Acknowledgment

Assistance from Baker Oil Tools, Inc., Trinity Portland Cement Company, and T. H. Brammer, Tide Water Associated Oil Company, has been most helpful in the preparation of this article.

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P 061.

Determining the Area of a Cylindrical Surface

by W. F. Schaphorst

A CHART for determining the area of any curved cylindrical surface is presented herewith. This chart is applicable to pipes, tubes, ducts, tanks, etc.

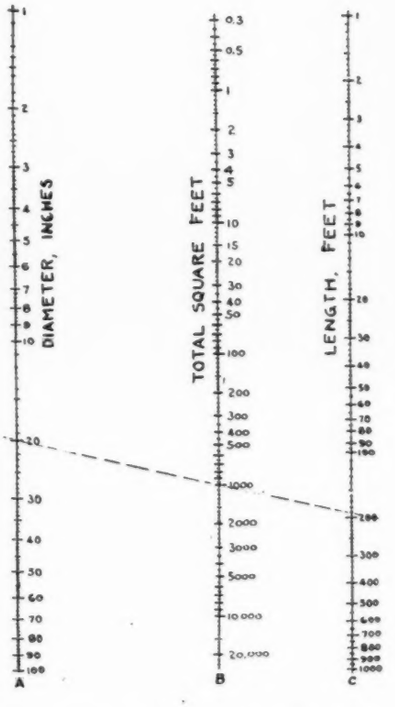
For example, the dotted line across the chart shows that if the diameter of the cylinder, pipe, tube, or tank, is 20 in., column A, and the length is 191 ft., column C, the total area is 1000 sq. ft., column B.

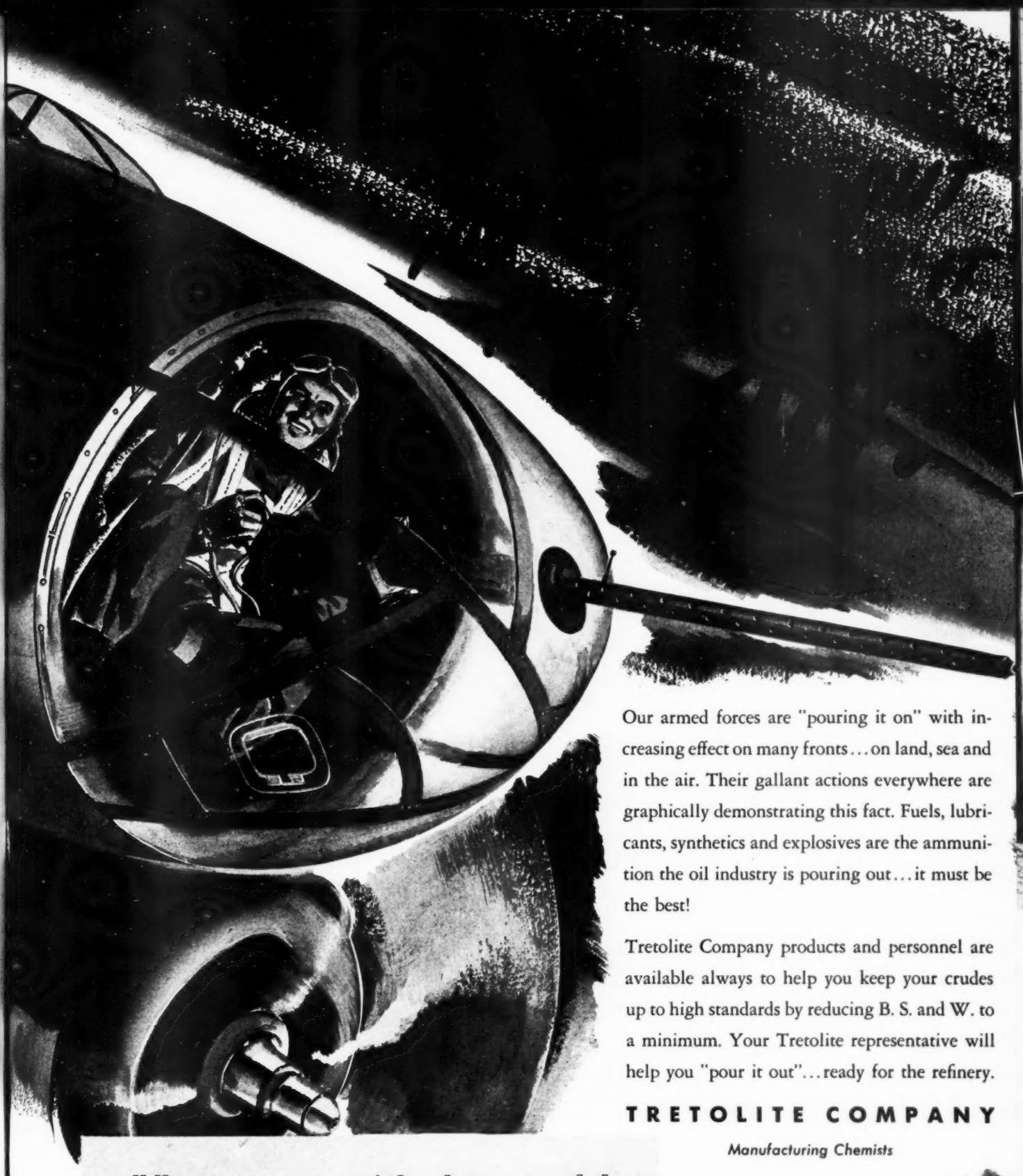
The chart covers a wide range—from 1 to 100 in. in diameter and from 1 to 1000 ft. in length. It can be applied to any diameter or length, however, as follows: Suppose you want to build a vertical tank of any material, 200 in. in diameter and 191 ft. high. What will be the area? These figures have been chosen purposely to show that the same dotted line already drawn across this chart can be used to solve the problem. The answer will be 10,000 sq. ft. instead of 1000 sq. ft. for reasons that are obvious.

In other words, if you add a cipher to the figure in column A, you must also add a cipher to the answer in column B; if you add 2 ciphers in column A you also add 2 ciphers in B, etc. The same is true of column C. To make sure that everything is understood let us add 2 ciphers to the 20 in column A, making the diameter 2000 in., and let us add 2 ciphers to the 191 in C making the height 19,100 ft. The number of sq. ft. will then be 10,000,000 because we must add a total of 4 ciphers to the figure in column B.

Note, please, that the tank just computed would be rather gigantic—nearly four miles high, and about 165 ft. in diameter. It has been included here only to demonstrate that the chart really has no limit of application. It will be found handy for estimating and for checking one's "hand figuring" should it be decided that utmost accuracy is wanted.

The chart will therefore be found useful for determining the area of any cylindrical structure of any kind or size. It can also be used "backwards" to advantage. For example, if 1000 sq. ft. of surface is wanted, column B, and if the diameter must be 20 in., column A, the same dotted line tells you that the length must be 191 ft., column C.





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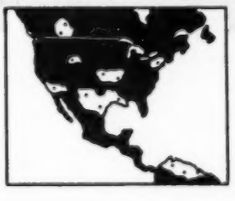

Natural Gas Cycling Course

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by Frank H. Dotterweich

Head, Division of Natural Gas Engineering, Texas College of Arts and Industries

DURING the last few years the processing of high-pressure natural gas, to recover natural gasoline and the return of the by-product dry gas to the sand from which it was taken, has developed into a highly specialized division of petroleum production and is now referred to as Natural Gas Cycling. This new industry is being called upon to provide stable natural gasolines and by-product butanes for the production of the very essential aviation fuels, in addition to supplying by-product hydrocarbons from which explosives, plastics, and rubber raw materials may be derived. The future should see greater amounts of the raw materials required in the rapidly expanding plastic industry supplied by the natural gasoline cycling plant. By modern means of separation relatively pure saturated hydrocarbons can be supplied, to be used as a base from which many products may be synthesized. In the development of most new industries many operating problems are encountered and natural gas cycling is no exception under these conditions; in addition, many unusual problems arise relating to the complex phenomena of hydrocarbon systems under high pressure in and out of their natural reservoir. With this fact in mind, and also the fact that men are being called from the petroleum industry to active duty in the armed forces, it was deemed advisable to offer a course in Natural Gas Cycling, on a college level, for the men in industry so that they could better acquaint themselves with all phases of cycling operations and be prepared to take over new or additional work should conditions dictate.

Gas Cycling Course

The natural gas cycling course as offered by the Engineering Department of the Texas College of Arts and Industries, Kingsville, was authorized by the United States Office of Education under its Engineering, Science and Management Defense Training Program. Forty-nine men signed up for the course and 32 received certification of the 72 hours credit given. Considering existing transportation problems and the distances traveled by the men to attend classes, the attendance was highly satisfactory. From time to time visitors attended the classes when outstanding topics were being taught. Of these, high-pressure absorption, stabilization, and high-pressure gas sampling appeared to be of the greatest interest. This work was taught by the writer and came under the supervision of Dr. A. W. Straiton, institutional representative of the ESMDT Program of the United States Office of Education.

FRANK H. DOTTERWEICH

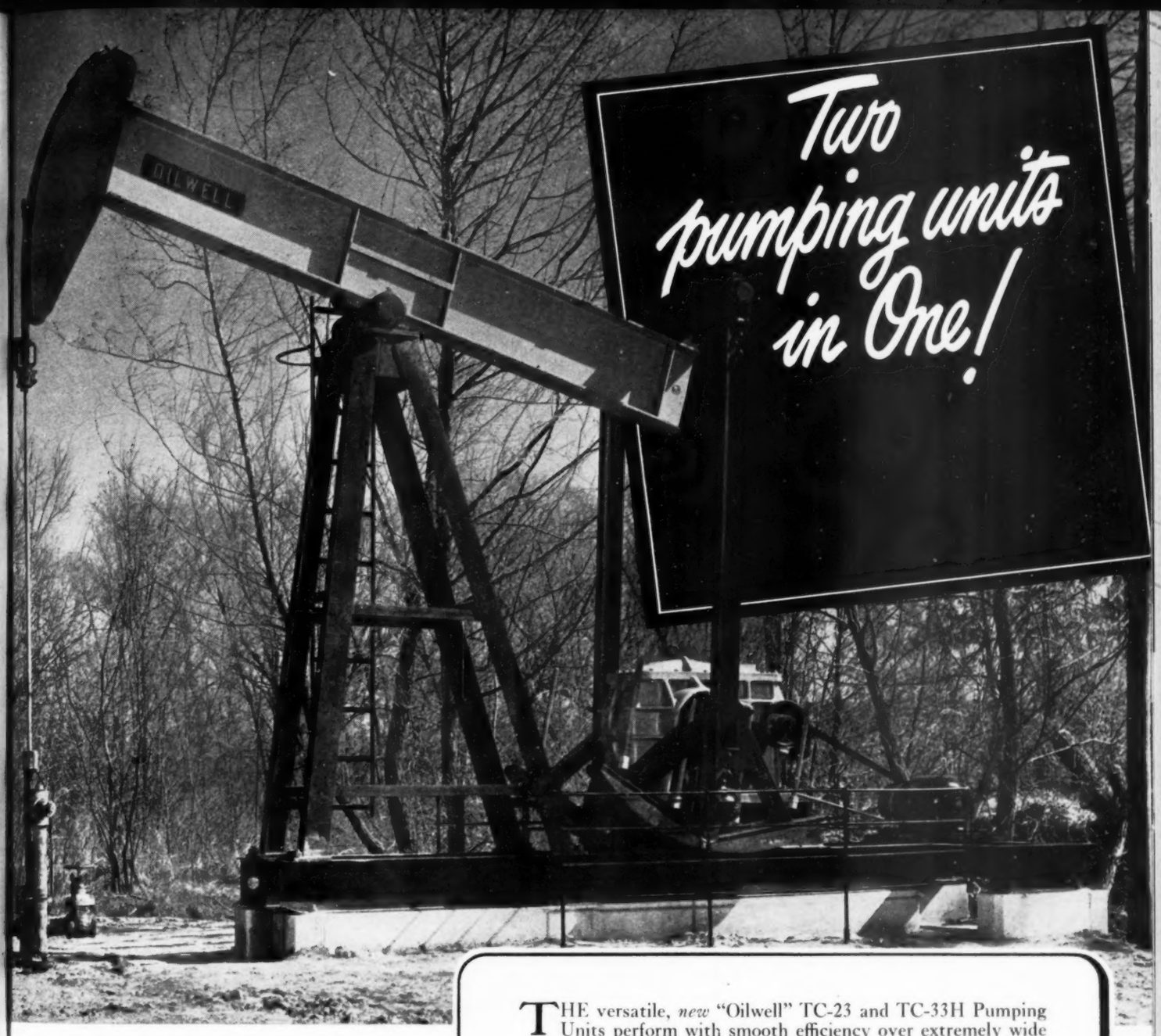
was recently granted a temporary leave of absence by Texas A. and I. to serve as consultant for the Office of Petroleum Co-ordinator in Washington, D. C.—He was graduated from the Baltimore Polytechnic Institute in June, 1923—Was employed by this institution as an instructor until June, 1925—Entered Johns Hopkins University in September, 1925, and received the degree of bachelor of engineering in gas engineering in June, 1928—Employed by the Consolidated Gas Electric Light and Power Company of Baltimore as a cadet engineer, general foreman, and assistant to general superintendent of gas operations—Re-entered Johns Hopkins University as a graduate student in October, 1934, and received degree of Ph.D. in June, 1937—Now heads the Division of Natural Gas Engineering, Texas College of Arts and Industries.

The course was for a period of 72 class hours, 12 lectures of three hours each, and 12 laboratory periods of three hours each. The lectures were held weekly, and due to the large enrollment, two laboratory sections were held weekly. The lectures covered the following subjects:

1. Development and growth of Natural Gas Cycling and its importance as a conservation measure.
2. Physical properties of hydrocarbon systems in condensate production with special emphasis on subsurface conditions and stage separation.
3. Predicting condensate recovery in cycling operations by the use of electrical models.
4. Determination of the open flow of gas wells as outlined by the U. S. Bureau of Mines. (Back-Pressure Data on Natural Gas Wells and Their Application to Production Practices. Monograph 7.)
5. The formation and prevention of natural gas hydrates.
6. Condensate gas sampling and testing.
7. High-pressure gas measurement and the deviation of natural gas from Boyle's Law.
8. Outline of plant, fundamental control tests, and plant operation.
9. Compression and transmission in gas cycling, fundamentals in heat transfer, and the design of coolers.
10. Fundamentals in high-pressure oil absorption, absorption and stripping factors, oil rate to absorbers, etc.
11. Fundamentals of distillation, the operation of stabilizers.
12. The use of natural gas and gasolines other than fuel and the future of the Natural Gasoline Cycling Industry.

The laboratory work consisted chiefly of natural gas measurement, routine plant tests and inspection trips in the field as follows:

1. The determination of dew points and specific gravity.
2. Gas analysis.
3. The one-tenth cu. ft. bottle and bell prover.
4. The use of the low-pressure and critical flow prover.
5. The open and closed pitot tube.
6. Calibration of chokes and the orifice meter.
7. Determination of the heating value of gas by the Junker Calorimeter.
8. Calibration of gauges.
9. Natural gasoline extraction and distillation tests.
10. Inspection of the Gulf Plains Cycling Plant.



Pumping this 3600-foot East Texas well *is a relatively light job today. But, should the load get really heavy, this "Oilwell" TC-23 Unit will go on pumping smoothly and with utmost reliability. Its great service range assures efficient operation as well conditions change over the years.*

SPECIFICATIONS

Unit	TC-23	TC-23	TC-33H	TC-33H
Set up for maximum stroke of . . (inches)	54	64-½	64	74
Polished-Rod Capacity (A.P.I. Rating) . . . . . (pounds)	17,400	16,000	21,000	19,500
Peak-Torque Capacity at 20 s.p.m. (A.P.I.) . . . . . (inch-lbs.)	115,800	115,800	160,600	160,600
Overall Gear Ratio	32.26:1	32.26:1	31.5:1	31.5:1

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THE versatile, *new* "Oilwell" TC-23 and TC-33H Pumping Units perform with smooth efficiency over extremely wide service ranges. *Each* unit is given the operating flexibility of *two* different units by a unique construction feature which makes available *two* combinations of stroke lengths. One combination provides longer strokes; the other provides higher polished-rod load capacities.

The conversion from one combination of stroke lengths to the other is accomplished by (1) reversing the position of the saddle trunnion assembly on the walking beam, and (2) moving the samson post on the base beams to an alternate set of bolt holes. No change in foundation nor extra machine work is required. The additional operating flexibility resulting from this conversion feature may prove to be a life-saver on a well in which pumping conditions are likely to change from time to time.

SOME OTHER TIME-PROVED ADVANTAGES

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- Precision-hobbed, fully heat-treated steel gears and pinions. All shafts rotate in shim-adjustable tapered roller bearings, rigidly supported in heavily ribbed, cast semi-steel gear cases.
- Mechanical brake with remote control.

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11. Inspection of the Wardner Cycling Plant.

12. Temperature measurements, the use of the optical pyrometer.

The 32 men completing the course are listed as follows, together with their employers and location:

Delmar Burris, Sun Oil Company, Driscoll, Texas; Otis Brinkman, La Gloria Corporation, Falfurrias, Texas; Thomas Lawrence Castle, La Gloria Corporation, Falfurrias; Logan Leslie Claunch, La Gloria Corporation, Falfurrias; W. L. Dunlap, Sun Oil Company, Freer, Texas; Harry Dutton, La Gloria Corporation, Falfurrias; Howard E. Fish, Transwestern Oil Company, Premont, Texas; C. J. Friedman, La Gloria Corporation, Falfurrias; Homer Charles Givens, La Gloria Corporation, Falfurrias; Virgil A. Goss, Agua Dulce Company, Refugio, Texas; Eugene Kell Gray, Humble Oil and Refining Company, Ingleside, Texas; R. E. Griffith, Stanolind Oil and Gas Company, Woodsboro, Texas; James Albert Grimshaw, The Chicago Corporation, Bishop, Texas; Roy Lee Hobbs, La Gloria Corporation, Falfurrias; R. E. Houser, La Gloria Corporation, Falfurrias; A. W. Lewis, La Gloria Corporation, Falfurrias; Howard L. Mills, U. S. Army, San Antonio, Texas; Richard D. Morgan, La Gloria Corporation, Falfurrias; Jens Peter Neilson, La Gloria Corporation, Falfurrias; George B. Parker, Humble Oil and Refining Company, Freer; Bernace F. Potts, Gulf Plains Corporation, Agua Dulce, Texas; Daniel B. Potts, La Gloria Corporation, Falfurrias; Guy Cecil Rainey, La Gloria Corporation, Falfurrias; G. W. Richardson, Magnolia Petroleum Company, Falfurrias; Clifford Lee Rush, La Gloria Corporation, Falfurrias; Henry John Scibienski, Gulf Plains Corporation, Bishop; Ruppert Simmons, Waggoner Refining Company, Bishop; Douglas E. Siems, Sun Oil Company, Freer; Lt. Robert Sparks (JG), U. S. Navy, Naval Air Station, Kingsville; Neville P. Sutton, La Gloria Corporation, Falfurrias; Oran W. White, Stanolind Oil and Gas Company, Woodsboro; James Brian Young, La Gloria Corporation, Falfurrias.

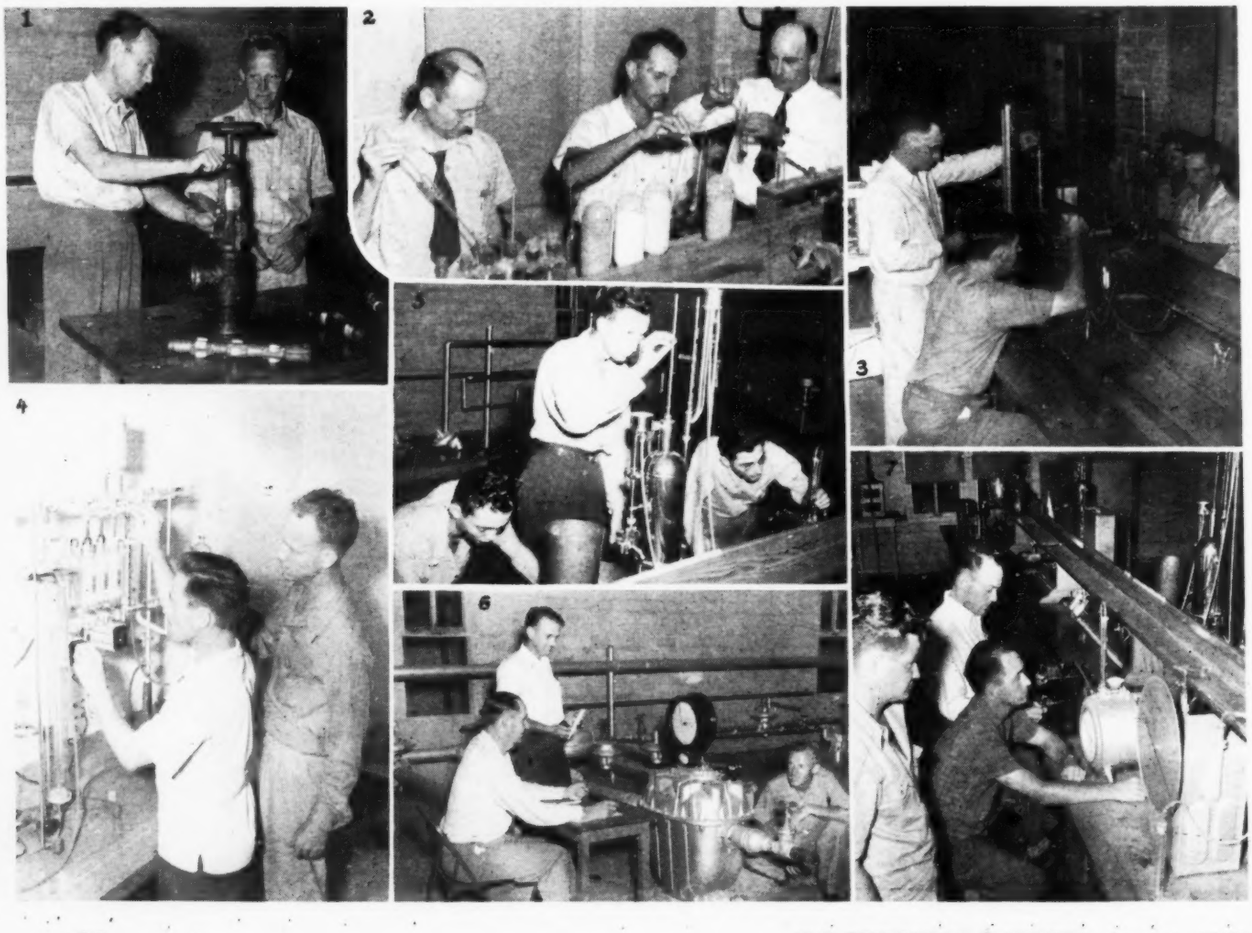
The interest shown by this group in Natural Gas Cycling indicates that additional work along these lines may be desirable. Although present conditions may temporarily affect the growth of this new industry, the return of normal conditions should see the Natural Gas Cycling Industry supplying large quantities of essential raw materials that will be required in the modern industry of tomorrow.

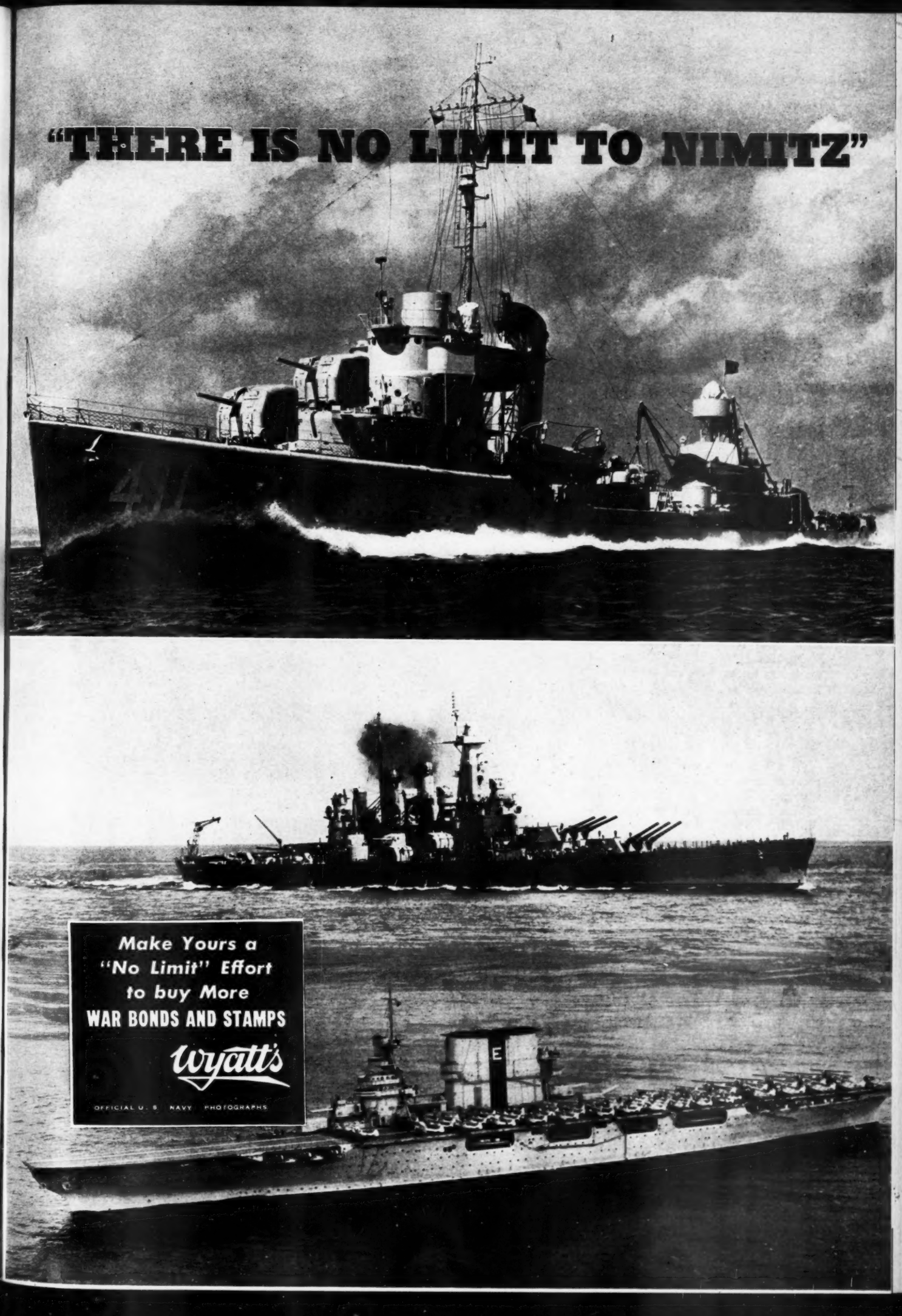
Acknowledgment

The writer wishes to make acknowledgment to C. R. Williams of The Chicago Corporation, Corpus Christi, Texas, for making possible the inspection trips and also to J. A. Grimshaw of the Wardner Plant and R. Simmons of the Gulf Plains Plant of the same corporation for their assistance during the plant inspections.

☆ ☆ ☆

1. *R. E. Houser (left) and H. E. Fish assemble a choke.* **2.** *Running a mud analysis. R. D. Morgan (left), C. L. Rush, and R. Simmons.* **3.** *Density and dew point determinations. Left to right: E. K. Gray, N. P. Sutton, J. A. Grimshaw, and G. C. Rainey.* **4.** *J. A. Grimshaw (left) and C. J. Friedman make a gas analysis.* **5.** *Operation of the Junker calorimeter to determine the B.t u. content of gas. Left to right: W. L. Dunlap, G. B. Parker, and B. F. Potts.* **6.** *Dan Potts (left) demonstrates the calibration of chokes to G. W. Richardson and H. C. Givens.* **7.** *J. B. Young (left), L. L. Claunch, and V. A. Goss study the operation of meters*

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Effect of Friction in Air Inlet and Exhaust Systems of Internal-Combustion Engines

PETROLEUM ENGINEER Exclusive Feature

PART 2 (Concluded)

by Orville Adams

A photograph and biographical sketch of the author of this article can be found on page 33 of the June issue of *The Petroleum Engineer* in connection with Part 1.

Nozzles

The flow of gas through nozzles, orifices, and ports is an important part of the theory used in Diesel engine design and operation. These problems present themselves in connection with the design of valves, valve lift, valve ports, starting-air valves, piping, inlet and exhaust ports for the 2-cycle engines, the passage in the air injection fuel nozzles, and any other place where air or gases flow through openings at relatively high velocities. Such processes are practically adiabatic, for the flow usually occurs at such high velocity, and requires such a minute increment of time that the absorption or loss of heat by conduction or transfer is prevented. The temperature of the gas decreases, but the heat (internal energy) of the gas is converted into kinetic energy of the gas. It is not intended to discuss here the cases of the inlet air and exhaust piping in which the pressure is virtually atmospheric and in which the velocity of the air or exhaust gases should be relatively low.

As stated, the flow of gases through ports or openings in which occurs an appreciable drop in gas pressure is an adiabatic process. The change in heat content of the gas is utilized to accelerate the gas, thus giving it kinetic energy. For example, consider the flow of 1 lb. of air from an initial pressure of 100 lb. per sq. in. abs. and 100° F. (560° abs.) through an orifice having an area at the throat or smallest section of 1-in. diameter, and exhausting into a region of 60 lb. per sq. in. abs. (For air: C_v=0.1715, C_p=0.240, γ=1.40, R = 53.34.) Then the original heat content of the gas is:

$$H = wC_pT = 1 \times 0.240 \times 560 = 134.4 \text{ B.t.u.}$$

The temperature after the process is:

$$T_2 = T_1\left(\frac{p_2}{p_1}\right)^{\frac{\gamma-1}{\gamma}} = 560\left(0.6\right)^{0.286}$$

$$= 560 \times 0.864 = 484° \text{ F. abs.}$$

Therefore, the decrease in temperature is 560 — 484 = 76°F.

The heat content of the gas has decreased 76 × 0.24 = 18.24 B.t.u. Converting this heat into kinetic energy gives the pound of air a velocity of:

$${}_1H_2 = \frac{wV^2}{50{,}056}, \text{ and}$$

$$V^2 = \frac{18.24 \times 50{,}056}{1}$$

V = 956 ft. per sec.

This last calculation represents the use of equation (2) allowing E_t to become zero as there is no change in the total energy. The equation then becomes:

$${}_1H_2 = \frac{wV^2}{2g778} = \frac{wV^2}{50{,}056}$$

The notation ${}_1H_2$ indicates the change in heat content of the gas between conditions 1 and 2. The density of the air at the throat of the nozzle is found from the pressure and temperature relationship, and using the simple equation:

$$pv = wRT = v = \frac{1 \times 53.34 \times 484}{144 \times 60}$$

= 2.988 lb. per cu. ft.

The weight of the air discharged per sec. is the product of the nozzle area times the velocity divided by the density or

$$w = \frac{a_t V}{D} \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

where:

w = weight of the gas delivered per sec.,

a_t = the throat area of the nozzle, sq. ft.,

V = the velocity of the gas in ft. per sec., and

D = the density of the gas in lb. per cu. ft.

In the above problem all the conditions are known for only one point, the throat of the nozzle. The same relationship as given in equation (7) would hold for any point in the process, and may be used if the respective values are known.

The nozzle has a throat diameter of 1 in., or an area of 0.7854 sq. in., which is equal to $\frac{0.7854}{144} = 0.005455$ sq. ft. Hence, according to equation (7):

$$w = \frac{0.005455 \times 960}{2.988}$$

= 1.745 lb. per sec.

The flow of all gases (expansible fluids) through nozzles must be considered from the standpoint of the critical pressure ratio. The critical pressure ratio may be defined as the ratio of the (1) pressure at which the gas increases in velocity as rapidly as its volume increases to (2) the initial pressure of the gas. Thus it is apparent that as a gas begins to expand through a nozzle it increases in velocity quite rapidly, whereas the specific volume increases slowly. This action requires that a nozzle be convergent in shape. Later, if the expansion process is carried to a sufficiently low pressure, the gas volume begins to increase more rapidly than the velocity. This action requires a nozzle of divergent or increasing area. At a given point between the convergent and divergent portions of the nozzle, there is a section of the nozzle that is cylindrical (see Fig. 1).

At the throat or point of critical pressure, the gas velocity and volume are increased at the same rate. It can be shown that for any gas the critical pressure is equal to:

$$p_c = p_1\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}} \quad . \quad . \quad (8)$$

where:

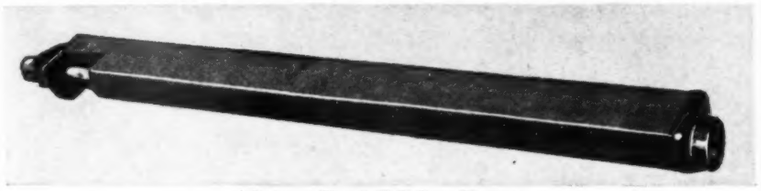
p_c = critical pressure of the gas,

p_1 = initial pressure of the gas,

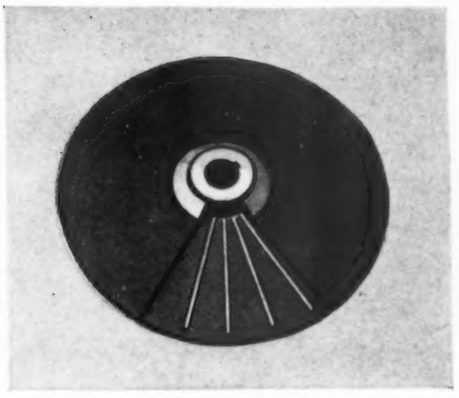
γ = the ratio of $\frac{C_p}{C_v}$ or the exponent of adiabatic expansion (1.40)

As an example: Find the critical pressure ratio for air, and the critical pressure for air as indicated in the

Cut-away Teardrop Diffuser Element.



Cut-away Type "A" Diffuser Element.



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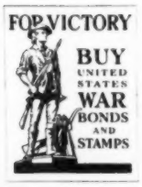

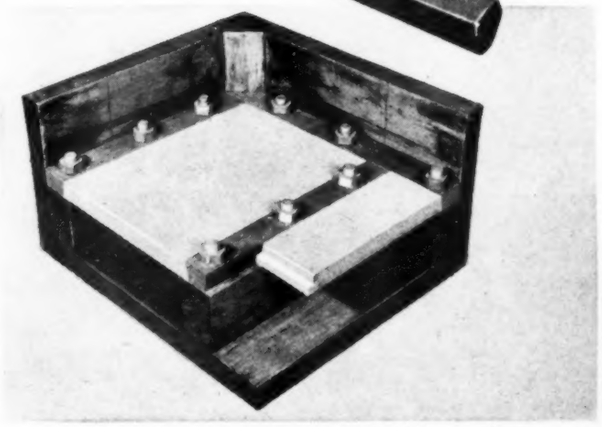

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above problem. The critical pressure ratio is:

$$\frac{p_c}{p_1} = \left(\frac{2}{\gamma + 1}\right)^{\frac{\gamma}{\gamma - 1}}$$

For air $\gamma = 1.4$ . . . . . (9)

$$\left(\frac{2}{1.4 + 1}\right)^{\frac{1.4}{1.4}} = \left(\frac{2}{2.4}\right)^{\frac{1.4}{1.4}} = 0.528$$

In the above problem, the initial pressure of the air was 100 lb. per sq. in. abs. and the critical pressure would be:

$p_c = 100 \times 0.528$
$= 52.8$ lb. per sq. in. abs.

In such a case, only the convergent portion of the nozzle would be needed, as the pressure did not decline below the critical pressure. For simplicity, the critical pressure may be designated as the ratio:

$$r_c = \frac{p_c}{p_1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

There are much simpler formulas than those used above for determining the flow of air or gases through well-rounded openings or nozzles. Two common formulas are as follows:

$$w = \frac{r_c a_t p_1}{\gamma T_1} \quad . \quad . \quad . \quad . \quad . \quad (11)$$

when:

$$w = 2 r_c a_t \sqrt{\frac{p_2 (p_1 - p_2)}{T_1}} \quad . \quad (12)$$

and

p_2 is equal to or less than $r_c p_1$ or p_c

when:

p_2 is equal to or greater than $r_c p_1$ or p_c

In each of these formulas:

- w = weight of gas flowing per sec., lb.,
- r_c = critical pressure ratio,
- p_1 = initial gas pressure, lb. per sq. in. abs.,
- p_2 = final gas pressure in the region of discharge, lb. per sq in. abs.,
- T_1 = the initial temperature of the gas, °F. abs., and
- a_t = the throat area or minimum nozzle area in sq. in.

In the problem discussed, equation (11) would be used, for the air is only used or expanded down to a discharge pressure of 60 lb. abs. Had the final discharge pressure been 52.8 lb. or lower, equation (12) would have been used. Equations (11 and 12) are frequently written for air calculations as follows:

$$w = \frac{53\, C\, a_t\, p_1}{\gamma T_1} \quad . \quad . \quad . \quad . \quad (11a)$$

and

$$w = 1.06\, C a_t \sqrt{\frac{p_2 (p_1 - p_2)}{T_1}} \quad . \quad (12a)$$

in which the values 0.53 and 1.06 represent r_c and $2r_c$, respectively, and a coefficient C is used to care for irregularities and excess friction losses in rough ports or nozzles. It would be enlightening to check the problem (which was solved above by fundamental relationships) by using equation (12a) and assuming a well-designed nozzle in which $C = 1.00$. This assumption was made in the original solution above.

$$w = 1.06 \times 0.7854 \sqrt{\frac{60(100 - 60)}{560}}$$

$$= 0.8352 \sqrt{\frac{2400}{560}}$$

$= 1.723$ lb. per sec.

This result constitutes a satisfactory check for the earlier solution. The factor 0.7854 represents the area of the nozzle at its minimum section. The diameter of 1 in. has an area of 0.7854 sq. in. It is of interest that equations (11 and 12) do not involve the exhaust or the final pressure conditions, whereas equations (11a and 12a) do involve the back pressure. This point is accounted for by the fact that the maximum flow of the gas is attained when the critical pressure is reached, and a further decrease in the back or exhaust pressure produces no additional flow or discharge through the opening. Fig. 2 gives a graphic illustration of the quantity of air discharged from a fixed initial pressure through a nozzle as the back pressure is varied from p_1 down to zero.

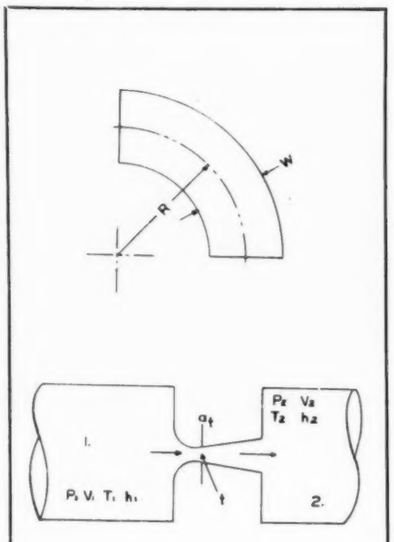


Fig. 1. Sketch for gas flow in nozzles

The process of a gas flowing through a nozzle is partially reversible, that is, the kinetic energy may be converted into heat by turbulence and friction in the region beyond the nozzle. The gas temperature could be increased from 468°F. to the original 560°F., if no other losses (radiation and convection of heat) were experienced by the gas. The pressure would be lost in such a process, and this would mean loss of availability of energy, not destruction of the energy.

Flow of Air in Ducts

Large increments of pressure, such as found in the engine and compressor cylinders, are measured in lb. per sq. in. Smaller increments of pressure, such as used in measuring air flow in ducts and inlet and exhaust pipes, are usually measured in in. of water pressure. A pressure of 1 lb. is equal to approximately 27.7 in. of water if the water is at its maximum density, 40°F. If the water is warmer, say 80°F., the variation is quite small, and the common value of 27.75 in. of water equals 1 lb. per sq. in. pressure is used. The factor is derived thus: 1 cu. ft. of water weighs 62.4 lb. at 40°F. and covers 144 sq. in. Therefore, a column of water 1 in. square and 1 ft. high weighs 62.4/144 or 0.4334 lb. A column of water only 1 in. high and 1 sq. in. in area would weigh $0.4334/12 = 0.03612$ lb., and would exert a pressure of 0.03612 lb. on the 1 sq. in. it covers. For a pressure of 1 lb. per sq. in., a column of water 1.000/0.03612, or 27.7 in., would be required.

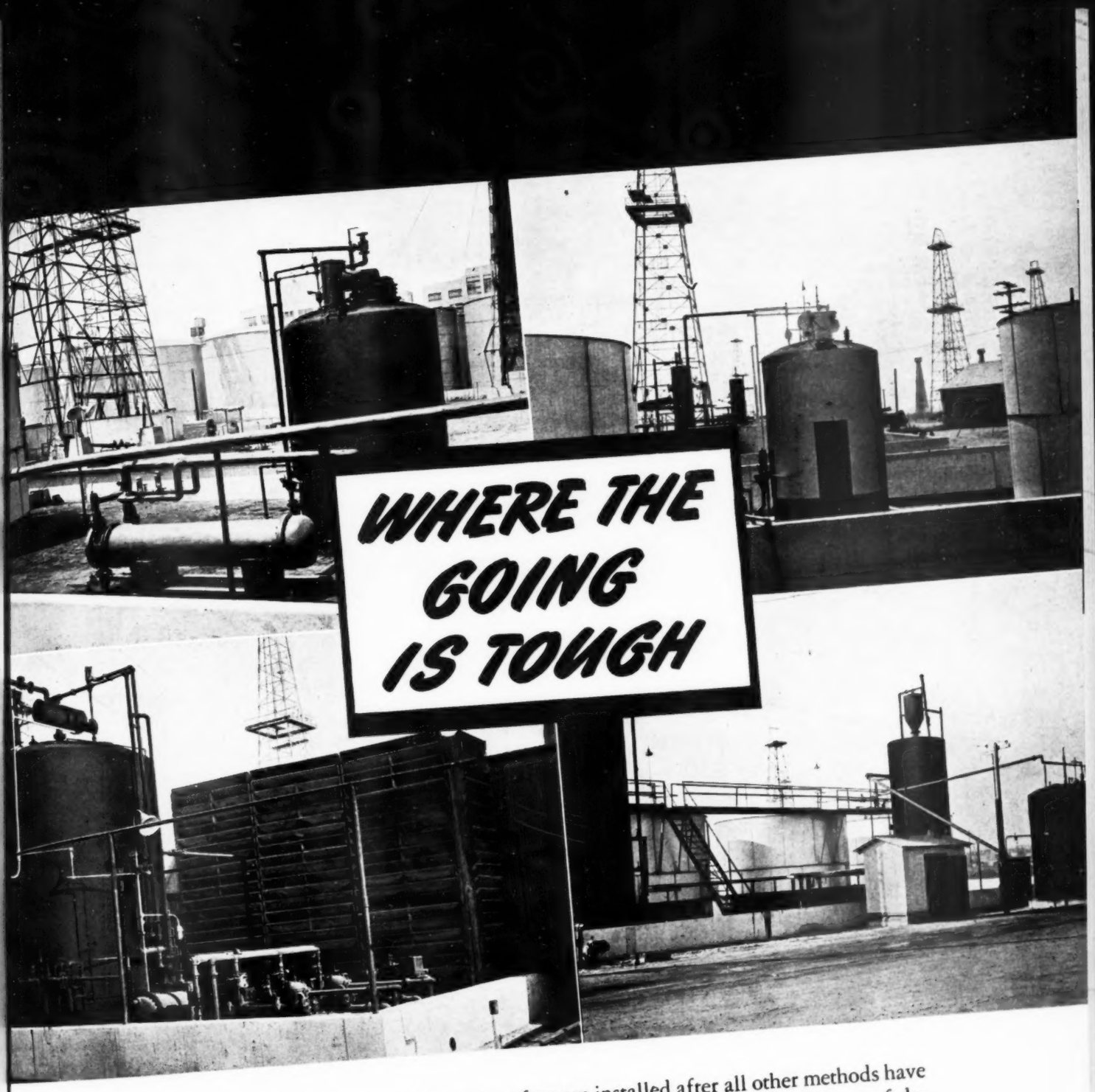
Air flowing in a duct or pipe has two forms of mechanical energy, (pressure energy and/or kinetic energy), not including its heat energy, which is not used in normal conditions of flow. The pressures are related as follows:

$$h_t = h_p + h_v \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

where:

- h_t = total pressure head,
- h_p = actual static pressure head, and
- h_v = velocity head, or pressure required to produce the velocity of air movement.

These values are usually measured in inches of water pressure. To convert velocity head in inches of water to velocity of air in ft. per min., let:



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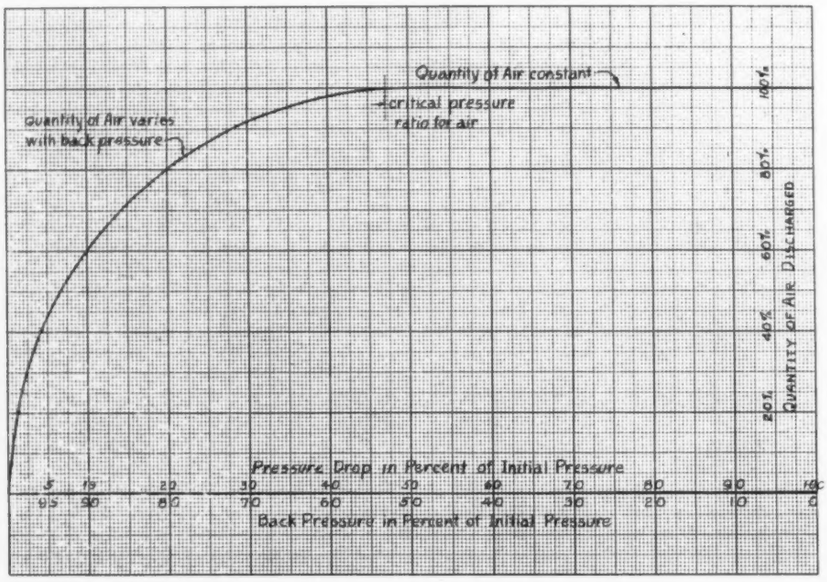


Fig. 2. Graphic illustration of the quantity of air discharged from a fixed initial pressure through a nozzle as the back pressure is varied from p_1 down to zero

D = density of air under given conditions,

D^1 = density of water, about 62.3 lb. per cu. ft. at 70°F.,

h_v = velocity head, in. of water, and h = velocity head, ft. of air.

Under this notation, the following relationships are written:

$$hD = \frac{h_v D^1}{12} \text{ or } h = \frac{h_v D^1}{12D}$$

From the laws of physics, we know the relationship for velocity and head:

$$V^2 = 2gh$$

Where:

V = velocity in ft. per sec., or

$V^2 = 3600 \times 2gh$

Where:

v = velocity in ft. per min. (3600 is 60^2 sec.)

Substituting the value of h derived above:

$$V^2 = 3600 \times 2g\left(\frac{h_v D^1}{12\ D}\right) = 3600 \times 64.34\ \frac{h_v}{12} \times \frac{62.3}{D} = 1{,}203{,}000\frac{h_v}{D}$$

and taking the square root of each:

$$V = 1096.5\sqrt{\frac{h_v}{D}} = 4005\sqrt{h_v} \quad . . (14)$$

This equation is used for air at or near standard conditions only. Using expressions prior to equation (14)

$$V^2 = 1{,}203{,}000\ \frac{h_v}{D}$$

or extracting the value of h_v from equation (14),

$$h_v = \left(\frac{V}{1096.5}\right)^2 D \quad . . . \quad (14a)$$

The total head or pressure difference required to cause air to flow in a duct or pipe is divided into static head and velocity head. The static head is used to overcome friction losses, and the velocity head is used to accelerate the air motion and cause it to flow. If a perfectly frictionless duct or pipe were available no static pressure would be required, and all energy of the air would be kinetic, the result or evidence of velocity head. The equations for velocity head are given in (14) and (14a).

For the conditions of a steady flow in a pipe or duct, the factor of resistance may be expressed in the equation:

$$Pa = FSDV^2$$

Where:

P = drop in pressure, lb. per sq. ft.,

a = the cross-sectional area of the pipe, sq. ft.,

F = a constant depending upon the nature of the fluid and condition of the pipe surface,

S = area of contact surface between fluid and the pipe, sq. ft.,

D = density of the fluid, lb. per cu. ft., and

V = the velocity of the fluid flow, ft. per sec.

To simplify this equation and to express it in a form typical of all flow equations, let F = f/2g, and substitute in the equation so that it shall read:

$$P = \frac{fSDV^2}{a \times 2g}$$

For round pipes having a diameter, d, and a length, L, the surface, $S = \pi dL$, and the cross-sectional area $a = \pi d^2/4$, which may be substituted in the equation as follows:

$$P = \frac{f\ \pi\ dL\ DV^2}{\frac{\pi d^2}{4} \times 2g} = \frac{4f\ LDV^2}{d \times 2g}$$

The weight of the gas flowing in lb. per min. is:

$$w = \frac{\pi d^2}{4} \times V \times D \times 60 = 47.12 d^2 VD$$

or:

$$V = \frac{w}{47.12\ d^2 D}$$

Using this value for V, and reducing the pressure drop to lb. per sq. in., p = P/144, and the diameter to in. by letting $d_1 = d/12$, the formula becomes:

$$\frac{P}{144} = p = 0.04839\ \frac{fw^2 L}{D d_1^5}$$

The coefficient f was found by Unwin to be:

$$f = K\left(1 + \frac{3}{10d}\right) = K\left(1 + \frac{3.6}{d_1}\right)$$

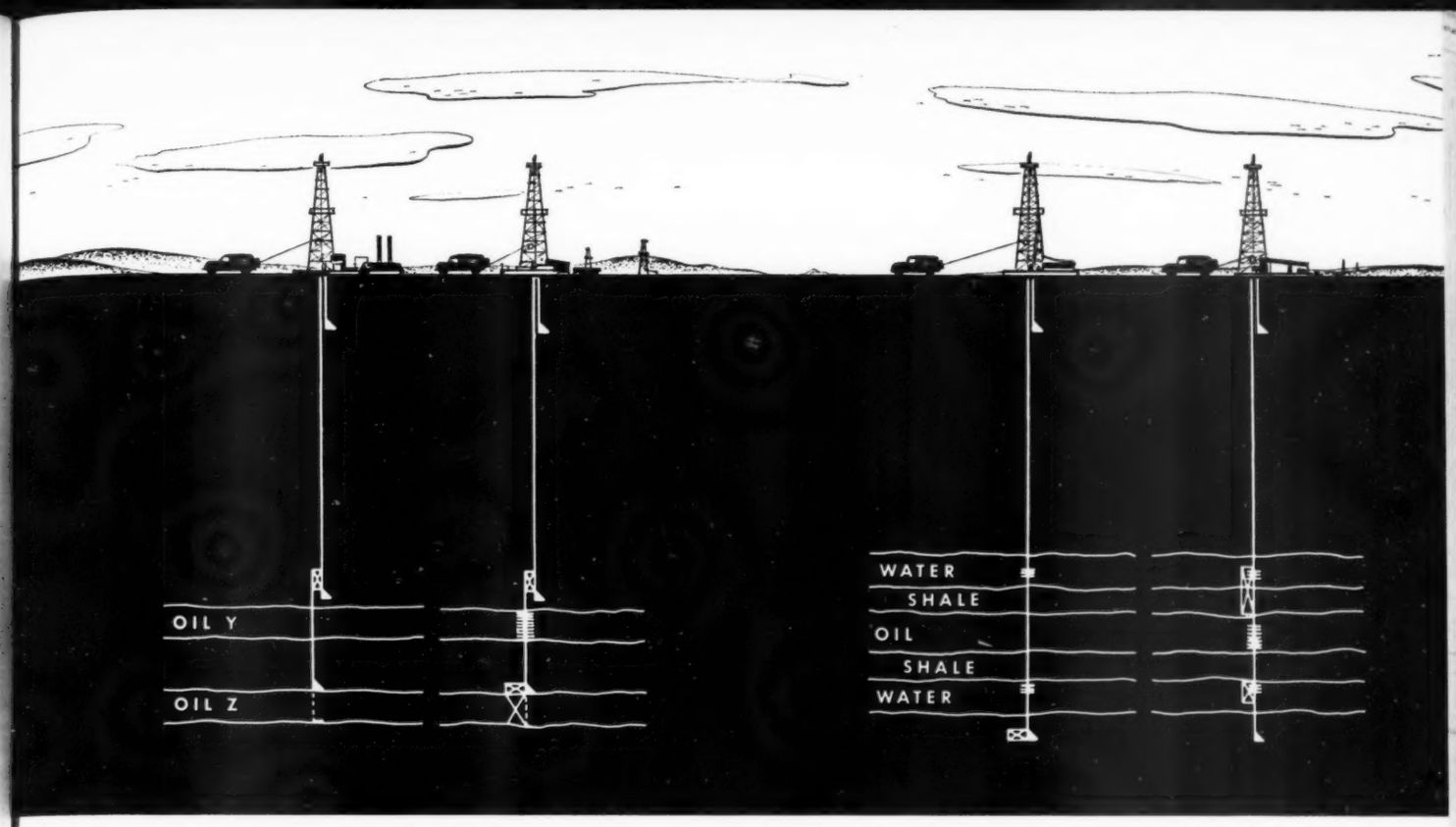
Various other investigators have determined values of f as a whole, or for the K in Unwin's coefficient, which results in the final form of the equation being:

$$p_d = 0.0001306\ w^2 L^1 \left(\frac{1 + \frac{3.6}{d_1}}{D\ d_1^5}\right) \quad . . . . . \quad (15)$$

which is for steam, and

$$p_d = 0.0001428\ w^2 L \left(\frac{1 + \frac{3.6}{d_1}}{D\ d_1^5}\right) \quad . . . . . \quad (16)$$

which is for air and all permanent gases, including superheated steam. In



To Correct High Gas/Oil Ratio--Where the entire sand section has been perforated and the well produces with an exceedingly high gas/oil ratio, operators can perform "squeeze" cement job through gun perforations in the gas sand. This makes it possible to close off entirely the free gas area and gun perforate only sufficient number of holes to allow the well to produce at the correct gas/oil ratio.

Water Exclusion--Water entries from below or above an oil zone to be perforated may be tested and the water completely excluded by perforating and "squeeze" cementing. This allows the oil sand to be produced efficiently.

These

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solving for the diameter or length of a pipe for a given pressure drop, other forms of equation (16) are as follows:

$$d_1 = \sqrt[5]{\frac{0.0003 w^2 L}{(p_1 - p_2) D}} = \sqrt[5]{\frac{3.0003\ QDL}{(p_1 - p_2)}} \quad . \quad . \quad (17)$$

$$L = \frac{7.000\ (p_1 - p_2)\ Dd_1^5}{\left(1 + \frac{3.6}{d_1}\right) w^2} = \frac{7.000\ (p_1 - p_2)\ d^5}{\left(1 + \frac{3.6}{d_1}\right) Q^2 D} \quad . \quad . \quad (18)$$

In these equations, the notation and symbols have the following meanings:

p_1 and p_2 = pressure at points 1 and 2 in the pipe,

$p_1 - p_2$ = P_d, the pressure drop or loss between points 1 and 2, respectively,

P_d = pressure drop, lb. per sq. in.,

Q = volume of fluid (gas), cu. ft. per min.,

w = weight of fluid (gas) flowing past a given point, lb. per min.,

d_1 = diameter of the pipe, in.,

D = density of the fluid, lb. per cu. ft., and

L = length of the pipe from points 1 to 2 in ft.

For low-pressure air or gas, such as intake air pipe, the equation is generally written to involve the perimeter, R, of the pipe or duct rather than the diameter. The equation then assumes the form:

$$P = \frac{fRL\ DV^2}{a\ 2g} \quad . \quad . \quad . \quad . \quad (19)$$

using the same notation as above.

The various forms of equations (17) and (18) are used in making calculations for all forms of air and gas pipe systems when the pressure is sufficiently high to be measured and studied in units of lb. per sq. in. Equation (19) ordinarily is used in chart form for simplicity and rapid calculations. Typical of such a chart is Fig. 3, which gives pipe sizes, air volumes, friction losses, and air velocity for straight pipe lengths of 100 ft. Fittings and obstructions must be considered in terms of the velocity head, and the losses thus determined are added to the losses in the straight pipe to determine the total frictional losses to be overcome by the static head pressure. Ducts of square or rectangular cross-section may be converted into friction equivalent of round ducts by reference to proper tables in a handbook.

Due to many possible radii on which a given diameter pipe or duct elbow may be made, it is customary to quote the pressure loss in percentage of the velocity head for the various ratios of "radius of elbow center-line to elbow width." For example, a duct or pipe that is 12 in. in diameter and has a center line radius of 18 in. is said to have a ratio of 1½ or 150 percent. The elbow would have an inside radius of 12 in. and an outside radius of 25 in. A table of such loss factors for

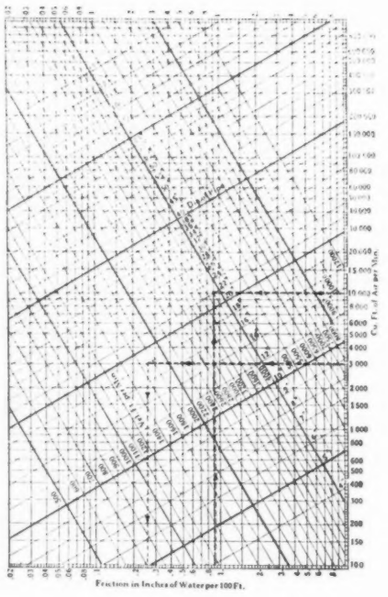

Fig. 3. Chart for determining friction of air in pipes

both round and square ducts taken from a handbook follows:

	Percent of velocity head loss	
Ratio of centerline radius to pipe width	*Round elbows percent*	*Square elbows percent*
0.60	52	53
0.75	38	33
1.00	26	18
1.50	17	9
2.00	15	8

As an example, let us determine the friction loss in a round duct 14 in. in diameter and 70 ft. long, having elbows whose center line radius is 21 in. The air is flowing at a velocity of 1200 ft. per min.

Solution: From the chart, find the intersection of the line for 1200 ft. velocity and the line for 14-in. pipe. This is about 0.19 in. per 100 ft., which would be $0.70 \times 0.19 = 0.133$ in. for 70 ft. The velocity head for air at standard conditions is found by using the equation:

$$h_v = \left(\frac{1200}{1096.5}\right)^2 \times 0.07488 = 0.0895 \text{ in.}$$

The elbows have a ratio of R/W = 21/14 = 150 percent, and from the accompanying table, the loss is found to be 17 percent of the velocity head for each elbow. The loss in both elbows, therefore, is $2 \times 0.17 \times 0.0895 = 0.0304$ in. The total loss in the pipe and the two elbows is the sum of these items, or:

$0.133 + 0.0304 = 0.1634$ in. of water.

If the above duct system is attached to an air filter whose resistance is 0.25 in. when clean, and 0.48 in. when relatively dirty, the total resistance to the flow of air varies from $0.25 + 0.1634 = 0.4134$ in. of water to $0.48 + 0.1634 = 0.6534$ in. of water. These figures are typical of air inlet systems for the two-stroke cycle engines, whereas similar figures for four-stroke engines as a rule will be higher.

Conclusions

It can be seen from the equations that friction losses in such duct systems are affected by the size, shape, surface roughness, and length of the pipe. Summing up, the following laws govern the friction of liquids and gases flowing in ducts or pipes, and all have been determined by experiments:

1. The frictional resistance varies approximately as much as the square of the velocity.
2. The frictional resistance varies directly with the area of contact between the fluid and the duct or pipe.
3. The frictional resistance varies directly as the density (weight per cu. unit) of the fluid.
4. The total frictional resistance is independent of its pressure against the wall of the duct or pipe.
5. Item 2 is influenced greatly by the nature of the duct surface. Smooth surfaces such as sheet metal or glass offer less resistance to flow than rough surfaces such as cast-iron, brick, and concrete.
6. Each obstruction, such as filters, mufflers, or baffles, etc., and each element or fitting that changes the direction of flow will offer resistance to the flow of the fluid or gases.

—— ☆ ☆ ☆ ——

THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT NO. 62

THIS is the second installment of the sixth year since the Continuous Tables were adopted as a valuable and regular feature of *The Petroleum Engineer*. Throughout the last five years the original objective of the tables, to save time and effort for the technician and the practical field or plant worker, has been strictly adhered to. As a result, their reception has been such as to lead the editors to believe that they are accomplishing their original objective. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer*.

The tables in the last 61 installments, 373 tables, have presented material that consisted of tabular data rather than graphs, curves, alignment charts, or other methods of presenting relationships between two or more variables. A part of the original objective was the presentation of the data in the simplest form available—tabular form data are believed the most accurate and readily followed by the average reader than any other method available. There are many types of information best presented by curves or nomographs when three or more variables must be considered simultaneously. Such data as must be presented in the form of charts and graphs has been begun in this installment.

Readers throughout the industry have indicated their interest in the source of so many tables. All the tables have developed as a result of suggestions for new tables, direct contributions, and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

To readers of *The Petroleum Engineer,* who are only now becoming interested in the Continuous Tables, it should be pointed out that each table is assigned a filing or index number that conforms with the Dewey Decimal System of classification as modified and extended for the petroleum and related industries by L. C. Uren, professor of Petroleum Engineering at the University of California. This complete index has been published in earlier installments of the tables and is now available in booklet form at a cost of 50 cents per copy from *The Petroleum Engineer,* P. O. Box 1589, Dallas, Texas. Complete sets of the tables from the first installment to the present are also available in conjunction with subscriptions.

Of the 61 installments of the Continuous Tables published to date, the number of tables in each division and their general field classification number follow:

Nos. P000-P399—General	50
Nos. P400-P499—Drilling	106
Nos. P500-P599—Production	79
Nos. P600-P699—Transportation and storage (includes pipe line)	92
Nos. P700-P799—Refining, including	
Nos. P770-P799—Natural Gasoline, which may be classified in a separate division as shown here if of special interest to the user	46
Total	373

INDEX TO TABLES*

Title of Table	*Index No.*	*Page*	*Issue*
Temperature conversion—Centigrade and Fahrenheit	P 061.001.	109	Aug.
Squares* of whole numbers	P 061.001.4	115	Aug.
Weight of dry material added to drilling mud, lb. per gal. (Sp. Gr. of additive=4.50)	P 425.218.43	107	Aug.
Hydrochloric acid solution schedule	(sheet 1) P 532.911.	103	Aug.
Solution of Weymouth's Formula for gas flow in large capacity gas lines	P 621.1	113	Aug.
Pipe line coefficients for gas flow—values of $d^{2.5}$	(sheet 4) P 622.001.	69	July
Pipe line coefficients for gas flow—values of $d^{2.5}$	(sheet 5) P 622.001.	73	July
Pump equivalents—gal. per minute	P 670.	105	Aug.
Pressure extensions—orifice meter calculations	(sheet 18) P 683.32	71	July
Pressures extensions—orifice meter calculations	(sheet 19) P 683.32	111	Aug.

*This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941 issue, and 48-60, inclusive in the June, 1942, issue.

INDEX TO ADVERTISERS IN TABLES

	Page	*Issue*	*Backing Table No.*
American Air Filter Company, Inc.	110	Aug.	P 061.001.
Bantam Bearings Corporation	116	Aug.	P 061.001.4
Bantam Bearings Corporation	(sheet 4) 70	July	P 622.001.
Chapman Valve Manufacturing Company, The	(sheet 19) 112	Aug.	P 683.32
Dearborn Chemical Company	114	Aug.	P 621.1
Graver Tank & Mfg. Co., Inc.	106	Aug.	P 670.
Hyatt Bearings Division, General Motors Sales Corporation	(sheet 1) 104	Aug.	P 532.911.
Hyatt Bearings Division, General Motors Sales Corporation	(sheet 5) 74	July	P 622.001.
LeRoi Company	108	Aug.	P 425.218.43
Vortox Manufacturing Company	(sheet 18) 72	July	P 683.32

HYDROCHLORIC ACID SOLUTION SCHEDULE

Be.°	Specific gravity at $\frac{60°F.}{60°F.}$	Percent HCl	Wt. in lb. per gal. at $\frac{60°F.}{60°F.}$	Gal. equivalent to 1 gal. of 15 percent HCl	Gal. of 15 percent HCl equivalent to 1 gal.	Gal. of 15 percent HCl equivalent to 1 lb.
4.90	1.03495	7.00	8.6282	2.2258	0.44928	0.05207
5.00	1.0357	7.15	8.6344	2.1775	0.45924	0.05319
5.25	1.0375	7.52	8.6494	2.0668	0.48385	0.05594
5.50	1.0394	7.89	8.6652	1.9662	0.50858	0.05869
5.57	1.0400	8.00	8.6703	1.9381	0.51597	0.05951
5.75	1.0413	8.26	8.6811	1.8748	0.53340	0.06144
6.00	1.0432	8.64	8.6969	1.7890	0.55897	0.06427
6.24	1.0449	9.00	8.7111	1.7147	0.58320	0.06695
6.25	1.0450	9.02	8.7120	1.7107	0.58455	0.06710
6.50	1.0469	9.40	8.7278	1.6386	0.61029	0.06992
6.75	1.0488	9.78	8.7436	1.5721	0.63611	0.07275
6.89	1.0499	10.00	8.7528	1.5359	0.65110	0.07439
7.00	1.0507	10.17	8.7595	1.5090	0.66267	0.07565
7.25	1.0526	10.55	8.7753	1.4521	0.68868	0.07848
7.50	1.0545	10.94	8.7912	1.3978	0.71542	0.08138
7.54	1.0548	11.00	8.7937	1.3898	0.71955	0.08183
7.75	1.0564	11.32	8.8070	1.3484	0.74161	0.08421
8.00	1.0584	11.71	8.8237	1.3010	0.76861	0.08711
8.19	1.05985	12.00	8.8358	1.2679	0.78873	0.08927
8.25	1.0603	12.09	8.8395	1.2579	0.79498	0.08994
8.50	1.0623	12.48	8.8562	1.2163	0.82217	0.09284
8.75	1.0642	12.87	8.8720	1.1773	0.84938	0.09574
8.83	1.0649	13.00	8.8779	1.1648	0.85852	0.09670
9.00	1.0662	13.26	8.8887	1.1406	0.87676	0.09864
9.25	1.0681	13.65	8.9045	1.1060	0.90416	0.10154
9.47	1.0699	14.00	8.9195	1.0765	0.92891	0.10414
9.50	1.0701	14.04	8.9212	1.0733	0.93173	0.10444
9.75	1.0721	14.43	8.9379	1.0423	0.95940	0.10734
10.00	1.0741	14.83	8.9546	1.0123	0.98784	0.11032
10.11	1.0750	15.00	8.9621	1.0000	1.00000	0.11158
10.25	1.0761	15.22	8.9712	0.98454	1.01570	0.11322
10.50	1.0781	15.62	8.9879	0.95755	1.04434	0.11619
10.74	1.08005	16.00	9.0042	0.93312	1.07168	0.11902
10.75	1.0801	16.01	9.0046	0.93249	1.07240	0.11910
11.09	1 0821	16 41	9.0213	0.90808	1.10123	0.12207
11.25	1.0841	16.81	9.0379	0.88484	1.13015	0.12505
11.37	1.08505	17.00	9.0458	0.87418	1.14393	0.12646
11.50	1.0861	17.21	9.0546	0.86268	1.15918	0.12802
11.75	1.0881	17.61	9.0713	0.84153	1.18831	0.13100
11.99	1.09015	18.00	9.0884	0.82175	1.21691	0.13390
12.00	1.0902	18.01	9.0888	0.82126	1.21764	0.13397
12.25	1.0922	18.41	9.1055	0.80194	1.24697	0.13695
12.50	1.0943	18.82	9.1230	0.78297	1.27719	0.14000
12.61	1.09525	19.00	9.1309	0.77488	1.29053	0.14134
12.75	1.0964	19.22	9.1405	0.76520	1.30684	0.14297
13.00	1.0985	19.63	9.1580	0.74779	1.33727	0.14602
13.23	1.1004	20.00	9.1738	0.73269	1.36484	0.14878
13.25	1.1006	20.04	9.1755	0.73109	1.36782	0.14907
13.50	1.1027	20.45	9.1930	0.71507	1.39846	0.15212
13.75	1.1048	20.86	9.2105	0.69968	1.42922	0.15517
13.84	1.1055	21.00	9.2163	0.69458	1.43972	0.15622

Be°, Specific Gravity at $\frac{60°\ F.}{60°\ F.}$, and percent HCL taken from HCL table in *Handbook of Chemistry and Physics.*

Weight in lb. per gal. at $\frac{60°\ F.}{60°\ F.} = 8.3368 \times$ sp. gr.

Gal. equivalent to 1 gal. of 15 percent HCL $= \frac{0.16125}{\text{sp. gr.} \times \frac{\text{percent HCL}}{100}}$

Gal. of 15 percent HCL equivalent to 1 gal. $= \frac{1}{\frac{0.16125}{\text{sp. gr.} \times \frac{\text{percent HCL}}{100}}}$

Gal. of 15 percent HCL equivalent to 1 lb. $= \frac{\text{percent HCL}}{100 \times 1.3443} = \frac{\text{percent HCL}}{134.43}$

This series of tables submitted by P. E. Fitzgerald, geologist, Dowell, Inc., Tulsa, Oklahoma.

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10	600	14,400		1.337	80.22	1925.3	0.24	14.28	342.9
12	720	17,280		1.604	96.26	2310.3	0.29	17.15	411.4
14	840	20,160		1.872	112.3	2695.4	0.33	20.00	480.0
16	960	23,040		2.139	128.4	3080.4	0.38	22.86	548.6
18	1,080	25,920		2.407	144.4	3465.5	0.43	25.72	617.1
20	1,200	28,800		2.674	164.4	3850.6	0.48	28.58	685.7
22	1,320	31,680		2.941	176.5	4235.7	0.52	31.44	685.7
24	1,440	34,560		3.208	192.5	4620.7	0.57	34.29	822.9
26	1,560	37,440		3.476	208.6	5005.8	0.62	37.15	891.4
28	1,680	40,320		3.744	224.6	5390.8	0.67	40.01	960.0
30	1,800	43,200		4.001	240.7	5775.9	0.71	42.87	1028.6
32	1,920	36,080		4.278	256.7	6160.9	0.76	45.73	1097.2
34	2,040	48,960		4.546	272.7	6546.0	0.81	48.59	1165.7
36	2,160	51,840		4.813	288.8	6931.1	0.86	51.44	1234.3
38	2,280	54,720		5.081	304.8	7316.1	0.90	54.30	1302.9
40	2,400	57,600		5.348	320.9	7701.2	0.95	57.16	1371.4
45	2,700	64,800	0.10	6.016	360.9	8663.8	1.07	64.31	1542.9
50	3,000	72,000		6.685	401.1	9626.5	1.19	71.45	1714.3
55	3,300	79,200		7.354	441.2	10,589	1.31	78.59	1885.7
60	3,600	86,400		8.022	481.3	11,552	1.43	85.74	2057.2
65	3,900	93,600		8.691	521.4	12,514	1.55	92.89	2228.6
70	4,200	100,800		9.359	561.5	13,477	1.66	100.0	2400.0
75	4,500	108,000		10.03	601.7	14,439	1.78	107.1	2571.5
80	4,800	115,200		10.69	641.8	15,402	1.90	114.3	2742.9
85	5,100	122,400		11.36	681.9	16,365	2.02	121.5	2914.3
90	5,400	129,600	0.20	12.03	721.9	17,328	2.14	128.6	3085.7
95	5,700	136,800		12.70	762.1	18,290	2.26	135.8	3257.2
100	6,000	144,000		13.37	802.2	19,253	2.40	142.9	3428.6
105	6,300	151,200		14.04	842.3	20,216	2.49	150.0	3600.0
110	6,600	158,400		14.71	882.4	21,178	2.62	157.2	3771.5
115	6,900	165,700		15.38	922.5	22,141	2.74	164.3	3942.9
120	7,200	172,800		16.04	962.6	23,104	2.86	171.5	4114.3
125	7,500	180,000		16.71	1002.7	24,066	2.98	178.6	4285.8
130	7,800	187,200		17.38	1042.8	25,029	3.09	185.8	4457.2
135	8,100	194,400	0.30	18.05	1082.9	25,992	3.21	192.9	4628.6
140	8,400	201,600		18.72	1123.1	26,954	3.33	200.1	4800.0
145	8,700	208,800		19.39	1163.2	27,917	3.45	207.2	4971.5
150	9,000	216,000		20.05	1203.3	28,879	3.57	214.3	5142.9
155	9,300	223,200		20.72	1243.4	29,842	3.69	221.5	5314.3
160	9,600	230,400		21.39	1283.5	30,805	3.81	228.6	5485.8
165	9,900	237,600		22.06	1323.6	31,767	3.93	235.8	5657.2
170	10,200	244,800		22.72	1363.7	32,730	4.05	242.9	5828.6
175	10,500	252,000		23.39	1403.8	33,693	4.16	250.0	6000.0
180	10,800	259,200	0.40	24.06	1443.9	34,655	4.28	257.2	6171.5
185	11,100	252,000		24.73	1484.1	35,618	4.40	264.4	6342.9
190	11,400	273,600		25.40	1524.2	36,581	4.52	271.5	6514.3
195	11,700	280,800		26.07	1564.3	37,543	4.64	278.7	6685.8

*24 hr. day.

†42 gal. bbl.

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PROTECTS a whole battery of conventional storage tanks against VAPOR LOSS

Illustrating method of manifolding ordinary storage tank to Expansion Roof Tank.

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One tank of suitable size, equipped with a Graver Expansion Roof, is manifolded to a number of ordinary storage tanks. As the vapors in these tanks expand they are forced into the vapor space of the Expansion Roofed Tank. Liquid sealed all around, the Roof rises to accommodate these expanding vapors, holding them instead of expelling them. Evaporation loss is thus eliminated.

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- ★ Evaporation losses eliminated. Octane rating maintained. Filling losses reduced to a minimum.
- ★ Requires minimum attention and will last longer than an ordinary storage tank. No breathing in of moisture laden air.
- ★ Conical roof prevents accumulation of snow or water.
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WELDED CONSTRUCTION
•
STRESS RELIEVING
•
X-RAYING
•
FABRICATED STEEL AND NON-CORROSIVE PLATE
•
WATER SOFTENERS
•
FILTRATION SYSTEMS
•
CLARIFIERS
•
SEWAGE EQUIPMENT

GRAVER

GRAVER TANK & MFG. CO., INC.

NEW YORK
CATASAUQUA, PA.

4809-30 Tod Ave.
EAST CHICAGO, IND.
CABLE ADDRESS — GRATANK

CHICAGO
TULSA

42-16-S

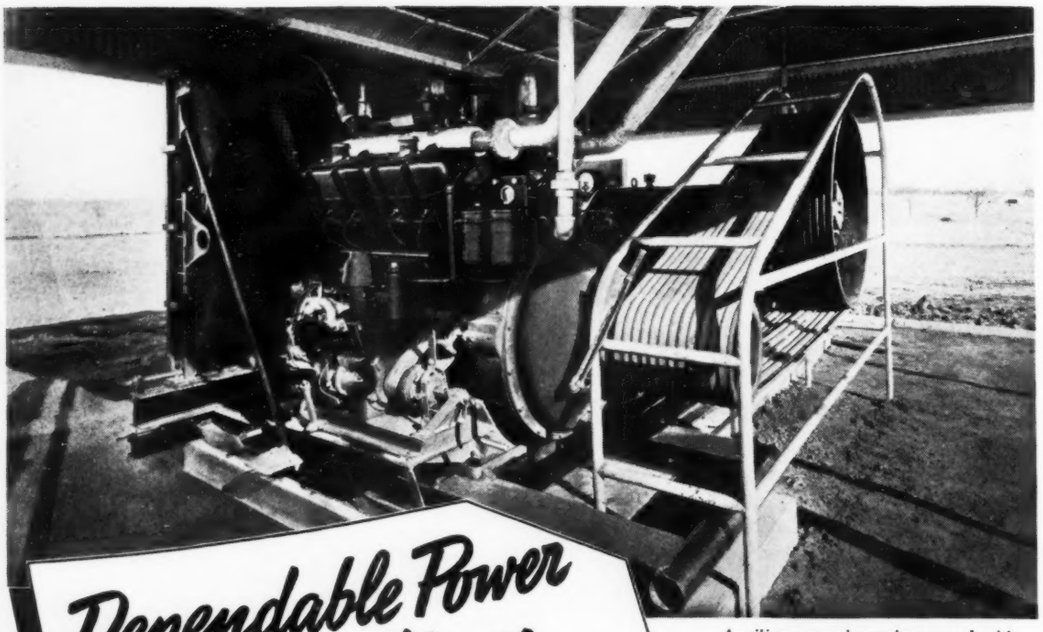
WEIGHT OF DRY MATERIAL ADDED TO DRILLING MUD, LB. PER GAL. (SP. GR. OF ADDITIVE = 4.50)

Original fluid, mud or water		Desired mud weight, lb. per gal.																				
Weight, lb. per gal.	Specific gravity	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5
	1.08	1.14	1.20	1.26	1.32	1.38	1.44	1.50	1.56	1.62	1.68	1.74	1.80	1.86	1.92	1.98	2.04	2.10	2.16	2.22	2.28	2.34
*8.345	1.00	0.87	1.57	2.28	3.01	3.78	4.57	5.39	6.27	7.15	8.09	9.05	10.1	11.5	12.7	13.9	15.2	16.5	17.9	19.4	21.0	22.7	24.4
9.0	1.08		0.68	1.37	2.09	2.83	3.61	4.41	5.26	6.13	7.04	7.99	8.98	10.0	11.1	12.2	13.4	14.7	15.9	17.3	18.8	20.3	21.9
9.5	1.14			0.69	1.39	2.13	2.89	3.68	4.51	5.36	6.26	7.18	8.16	9.26	10.3	11.3	12.5	13.8	15.0	16.4	17.8	19.3	20.9
10.0	1.20				0.71	1.41	2.16	2.94	3.76	4.59	5.47	6.38	7.34	8.34	9.43	10.5	11.6	12.9	14.1	15.4	16.8	18.3	19.8
10.5	1.26					0.72	1.44	2.21	3.00	3.83	4.69	5.59	6.53	7.51	8.51	9.59	10.7	11.9	13.2	14.4	15.8	17.3	18.8
11.0	1.32						0.73	1.47	2.25	3.06	3.91	4.79	5.71	6.68	7.68	8.76	9.85	11.0	12.2	13.5	14.9	16.3	17.8
11.5	1.38							0.75	1.50	2.30	3.13	3.99	4.89	5.84	6.83	7.86	8.93	10.1	11.3	12.5	13.9	15.2	16.7
12.0	1.44								0.77	1.54	2.34	3.19	4.08	5.01	5.97	6.98	8.04	9.18	10.3	11.5	12.9	14.2	15.7
12.5	1.50									0.78	1.57	2.39	3.26	4.17	5.09	6.09	7.18	8.26	9.43	10.6	11.8	13.2	14.6
13.0	1.56										0.79	1.59	2.45	3.34	4.26	5.23	6.26	7.34	8.43	9.59	10.8	12.2	13.6
13.5	1.62											0.81	1.64	2.50	3.42	4.34	5.34	6.43	7.51	8.68	9.85	11.2	12.5
14.0	1.68												0.83	1.67	2.59	3.50	4.51	5.51	6.59	7.68	8.93	10.2	11.5
14.5	1.74													0.84	1.70	2.62	3.59	4.59	5.67	6.76	7.93	9.09	10.4
15.0	1.80														0.87	1.74	2.68	3.67	4.67	5.76	6.93	8.09	9.35
15.5	1.86															0.88	1.79	2.75	3.76	4.84	5.92	7.09	8.35
16.0	1.92																0.91	1.83	2.81	3.84	4.92	6.01	7.34
16.5	1.98																	0.93	1.88	2.92	3.92	5.09	6.26
17.0	2.04																		0.95	1.92	3.00	4.09	5.26
17.5	2.10																			0.98	2.00	3.00	4.17
18.0	2.16																				1.00	2.00	3.25
18.5	2.22																					1.00	2.09
19.0	2.28																						1.08

Note: The body of this table supplies the weight in lb. of the dry solid to be added per gal. to drilling fluid of known weight to obtain a mud of higher weight. The above table was calculated with an additive of sp. gr. of 4.5.

To use table find weight of original mud in left-hand column and desired mud weight in top line. Multiply figure from body of table by the volume of mud in gal. in well or mud pit to obtain the total amount in lb. of dry material to be added to obtain the desired mud weight.

*Water.



Auxiliary pumping unit powered with Le Roi RX1V engine. Installed in a main pipe-line station at Healdton, Oklahoma. Now on 24-hour duty.

Dependable Power for Pipe Lines

. . . the life lines of our war economy . . . with

LE ROI ENGINES

operating on Gasoline — Natural Gas — Butane

Steady, uninterrupted service in transporting petroleum and its products through pipe lines has become a matter of grave concern to the nation. Here Le Roi engines are doing their part for both major and independent companies — standing up, with minimum maintenance, under the grind of 24-hour operation. • Behind this performance is a quarter-century of experience in designing and building heavy-duty engines for industry's tough jobs. Le Roi features assure you of low first cost — low installation cost — low operating and maintenance cost — and the extra reserves of power, the extra factors of safety that pull you through emergencies. • Power your next pipe line job with Le Roi engines, and be confident of results that back up your good judgment. Write, stating size of engine in which you are interested, and we will send bulletins giving complete details.

- 4 to 100 H. P. engines for gathering and pick-up pumps.
- 100 to 400 H. P. sizes for main line, standby, or emergency service — capable of handling 12,000 to 35,000 barrels per day.
- Engine and pump may be assembled as a single unit.
- Compact stationary unit with portable features — readily transferred.

P-12

LE ROI COMPANY, MILWAUKEE, WIS. • TULSA, OKLA.

Southern Engine & Pump Company, Houston — Dallas — Kilgore, Texas
General Machine & Supply Company, Wichita Falls — Odessa, Texas
Western Machinery Company, St. Louis, Missouri • Centralia, Illinois

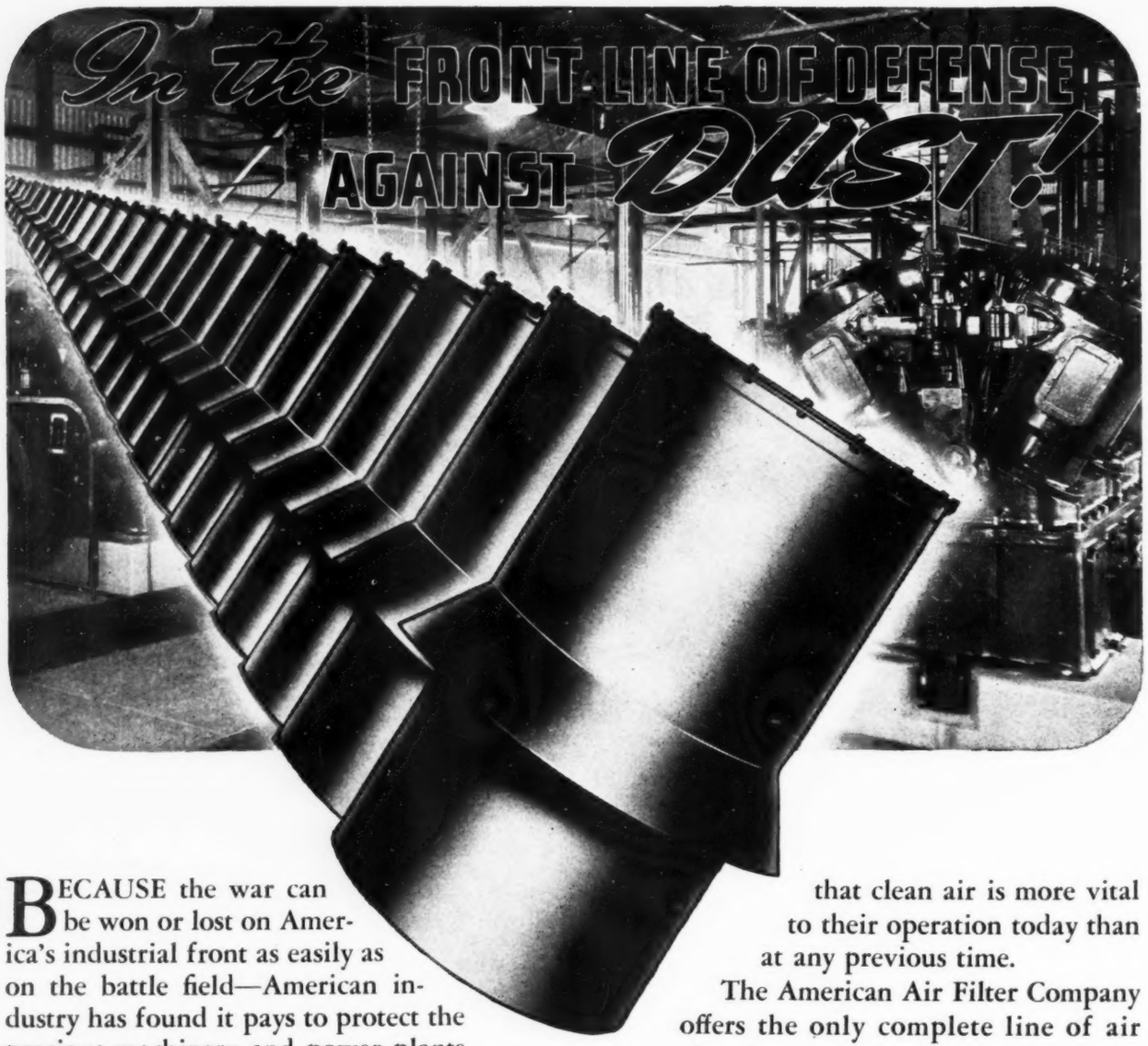
TEMPERATURE CONVERSION—FAHRENHEIT AND CENTIGRADE

Temp., °C. or °F.	°C.	°F.	Temp., °C. or °F.	°C.	°F.	Temp., °C. or °F.	°C.	°F.	Temp., °C. or °F.	°C.	°F.
0	—17.8	32.0	50	10.0	122.0	100	38	212	590	310	1094
1	—17.2	33.8	51	10.6	123.8	110	43	230	600	316	1112
2	—16.7	35.6	52	11.1	125.6	120	49	248	610	321	1130
3	—16.1	37.4	53	11.7	127.4	130	54	266	620	327	1148
4	—15.6	39.2	54	12.2	129.2	140	60	284	630	332	1166
5	—15.0	41.0	55	12.8	131.0	150	66	302	640	338	1184
6	—14.4	42 8	56	13.3	132.8	160	71	320	650	343	1202
7	—13.9	44.6	57	13.9	134.6	170	77	338	660	349	1220
8	—13.3	46.4	58	14.4	136.4	180	82	356	670	354	1238
9	—12.8	48.2	59	15.0	138.2	190	88	374	680	360	1256
10	—12.2	50.0	60	15.6	140.0	200	93	392	690	366	1274
11	—11.7	51.8	61	16.1	141.8	210	99	410	700	371	1292
12	—11.1	53.6	62	16.7	143.6	212	100	413	710	377	1310
13	—10.6	55.4	63	17.2	145.4	220	104	428	720	382	1328
14	—10.0	57.2	64	17.8	147.2	230	110	446	730	388	1346
15	— 9.44	59.0	65	18.3	149.0	240	116	464	740	393	1364
16	— 8.89	60.8	66	18.9	150.8	250	121	482	750	399	1382
17	— 8.33	62.6	67	19.4	152.6	260	127	500	760	404	1400
18	— 7.78	64.4	68	20.0	154.4	270	132	518	770	410	1418
19	— 7.22	66.2	69	20.6	156.2	280	138	536	780	416	1436
20	— 6.67	68.0	70	21.1	158.0	290	143	554	790	421	1454
21	— 6.11	69.8	71	21.7	159.8	300	149	572	800	427	1472
22	— 5.56	71.6	72	22.2	161.6	310	154	590	810	432	1490
23	— 5.00	73.4	73	22.8	163.4	320	160	608	820	438	1508
24	— 4.44	75.2	74	23.3	165.2	330	166	626	830	443	1526
25	— 3.89	77.0	75	23.9	167.0	340	171	644	840	449	1544
26	— 3.33	78.8	76	24.4	168.8	350	177	662	850	454	1562
27	— 2.78	80.6	77	25.0	170.6	360	182	680	860	460	1580
28	— 2.22	82.4	78	25.6	172.4	370	188	698	870	466	1598
29	— 1.67	84.2	79	26.1	174.2	380	193	716	880	471	1616
30	— 1.11	86.0	80	26.7	176.0	390	199	734	890	477	1634
31	— 0.56	87.8	81	27.2	177.8	400	204	752	900	482	1652
32	0.00	89.6	82	27.8	179.6	410	210	770	910	488	1670
33	0.56	91.4	83	28.3	181.4	420	216	788	920	493	1688
34	1.11	93.2	84	28.9	183.2	430	221	806	930	499	1706
35	1.67	95.0	85	29.4	185.0	440	227	824	940	504	1724
36	2.22	96.8	86	30.0	186.8	450	232	842	950	510	1742
37	2.78	98.6	87	30.6	188.6	460	238	860	960	516	1760
38	3.33	100.4	88	31.1	190.4	470	243	878	970	521	1778
39	3.89	102.2	89	31.7	192.2	480	249	896	980	527	1796
40	4.44	104.0	90	32.2	194.0	490	254	914	990	532	1814
41	5.00	105.8	91	32.8	195.8	500	260	932	1000	538	1832
42	5.56	107.6	92	33.3	197.6	510	266	950			
43	6.11	109.4	93	33.9	199.4	520	271	968			
44	6.67	111.2	94	34.4	201.2	530	277	986			
45	7.22	113.0	95	35.0	203.0	540	282	1004			
46	7.78	114.8	96	35.6	204.8	550	288	1022			
47	8.33	116.6	97	36.1	206.6	560	293	1040			
48	8.89	118.4	98	36.7	208.4	570	299	1058			
49	9.44	120.2	99	37.2	210.2	580	304	1076			

Factors for interpolation

Temp., °C. or °F.	°C.	°F.	Temp., °C. or °F.	°C.	°F.
1	0.56	1.8	6	3.33	10.8
2	1.11	3.6	7	3.89	12.6
3	1.67	5.4	8	4.44	14.4
4	2.22	7.2	9	5.00	16.2
5	2.78	9.0	10	5.56	18.0

NOTE: Numbers in the column "Temperature, °C. or °F." refers to the temperature in either Centigrade or Fahrenheit which it is desired to convert. The columns headed "°C." and "°F." contain the equivalent temperatures to those given in the first column.



BECAUSE the war can be won or lost on America's industrial front as easily as on the battle field—American industry has found it pays to protect the precious machinery and power plants they must depend upon in order to meet our war demands. American Air Filter equipment has been an important factor in accelerating deliveries of war materials and saving valuable machinery from destruction by abrasive dust. Production schedules accelerated many times normal have doubled or trebled the running time of gas engines, diesels and compressors in use throughout the nation, which means that clean air is more vital to their operation today than at any previous time.

The American Air Filter Company offers the only complete line of air cleaning equipment made for engine and compressor service. Outstanding among the several types available is the Cycoil Oil Bath Air Cleaner which offers exclusive 4-way cleaning, assuring positive dust protection under the most severe conditions. Send for bulletins describing American Air Filter equipment for engine and compressor requirements. These bulletins are available without obligation.

AMERICAN AIR FILTERS

AMERICAN AIR FILTER COMPANY, INC.

384 CENTRAL AVENUE LOUISVILLE, KY. In Canada, Darling Bros., Ltd. Montreal

Cycoil oil bath AIR CLEANERS

Static Press. 1800-1895 lb.

PRESSURE EXTENSIONS—ORIFICE METER CALCULATIONS

Differential pressure, in. of water	Static pressure, lb. per sq. in., ga.																			
	1800	1805	1810	1815	1820	1825	1830	1835	1840	1845	1850	1855	1860	1865	1870	1875	1880	1885	1890	1895
2	60.24	60.32	60.41	60.49	60.58	60.66	60.73	60.82	60.90	60.99	61.06	61.14	61.23	61.31	61.40	61.47	61.55	61.64	61.72	61.79
4	85.20	85.32	85.44	85.56	85.68	85.80	85.90	86.02	86.14	86.26	86.36	86.48	86.60	86.72	86.84	86.94	87.06	87.18	87.30	87.40
6	104.3	104.5	104.6	104.8	104.9	105.1	105.2	105.3	105.5	105.6	105.7	105.9	106.0	106.2	106.3	106.5	106.6	106.8	106.9	107.0
8	120.5	120.6	120.8	120.9	121.2	121.3	121.5	121.6	121.8	121.9	122.1	122.3	122.5	122.6	122.8	122.9	123.1	123.3	123.4	123.6
10	134.7	134.9	135.1	135.3	135.5	135.6	135.8	135.9	136.2	136.4	136.5	136.7	136.9	137.1	137.3	137.5	137.6	137.8	138.0	138.2
12	147.6	147.8	147.9	148.2	148.4	148.6	148.8	148.9	149.2	149.4	149.6	149.8	149.9	150.2	150.4	150.6	150.8	150.9	151.2	151.4
14	159.4	159.6	159.9	160.1	160.3	160.5	160.7	160.9	161.2	161.4	161.6	161.8	162.0	162.3	162.5	162.7	162.9	163.1	163.3	163.5
16	170.4	170.6	170.9	171.1	171.4	171.6	171.8	172.0	172.3	172.5	172.7	172.9	173.2	173.4	173.7	173.9	174.1	174.4	174.6	174.8
18	180.8	181.0	181.3	181.5	181.8	182.0	182.2	182.5	182.7	183.0	183.2	183.5	183.7	183.9	184.2	184.4	184.7	184.9	185.2	185.4
20	190.5	190.8	191.0	191.3	191.6	191.8	192.1	192.3	192.6	192.9	193.1	193.4	193.6	193.9	194.2	194.4	194.7	194.9	195.2	195.4
21	195.2	195.5	195.8	196.1	196.3	196.6	196.8	197.1	197.4	197.7	197.9	198.2	198.4	198.7	198.9	199.2	199.5	199.8	200.0	200.3
22	199.8	200.1	200.4	200.6	200.9	201.2	201.4	201.7	201.9	202.3	202.5	202.8	203.1	203.4	203.6	203.9	204.2	204.4	204.7	204.9
23	204.3	204.6	204.9	205.2	205.5	205.7	205.9	206.3	206.6	206.9	207.1	207.4	207.7	207.9	208.2	208.5	208.8	209.1	209.3	209.6
24	208.7	208.9	209.3	209.6	209.9	210.2	210.4	210.7	210.9	211.3	211.5	211.8	212.1	212.4	212.7	212.9	213.3	213.5	213.8	214.1
25	213.0	213.3	213.6	213.9	214.2	214.5	214.8	215.1	215.4	215.7	215.9	216.2	216.5	216.8	217.1	217.4	217.7	217.9	218.3	218.5
26	217.2	217.5	217.8	218.1	218.4	218.7	219.0	219.3	219.6	219.9	220.2	220.5	220.8	221.1	221.4	221.7	221.9	222.3	222.6	222.8
27	221.3	221.7	221.9	222.3	222.6	222.9	223.2	223.5	223.8	224.1	224.4	224.7	224.9	225.3	225.6	225.9	226.2	226.5	226.8	227.1
28	225.4	225.8	226.1	226.4	226.7	227.0	227.3	227.6	227.9	228.2	228.5	228.8	229.1	229.5	229.8	230.0	230.4	230.7	230.9	231.3
29	229.4	229.7	230.0	230.4	230.7	231.0	231.3	231.6	231.9	232.3	232.5	232.8	233.2	233.5	233.8	234.1	234.4	234.7	235.1	235.3
30	233.3	233.6	233.9	234.3	234.6	234.9	235.2	235.6	235.9	236.2	236.5	236.8	237.2	237.5	237.8	238.1	238.4	238.7	239.1	239.3
31	237.2	237.5	237.9	238.2	238.5	238.9	239.1	239.5	239.8	240.1	240.4	240.8	241.1	241.4	241.8	242.0	242.4	242.7	243.0	243.3
32	240.9	241.3	241.7	242.0	242.3	242.7	242.9	243.3	243.6	243.9	244.3	244.6	244.9	245.3	245.6	245.9	246.2	246.6	246.9	247.2
33	244.7	245.1	245.4	245.8	246.1	246.5	246.7	247.1	247.4	247.8	248.1	248.4	248.8	249.1	249.4	249.7	250.1	250.4	250.8	251.1
34	248.4	248.7	249.1	249.5	249.8	250.1	250.4	250.8	251.1	251.5	251.8	252.1	252.5	252.8	253.2	253.5	253.8	254.2	254.5	254.8
35	252.0	252.4	252.7	253.1	253.4	253.8	254.1	254.4	254.8	255.2	255.5	255.8	256.2	256.5	256.9	257.2	257.5	257.9	258.2	258.5
36	255.6	255.9	256.3	256.7	257.1	257.4	257.7	258.1	258.4	258.8	259.1	259.4	259.8	260.2	260.5	260.8	261.2	261.5	261.9	262.2
37	259.1	259.5	259.9	260.2	260.6	260.9	261.3	261.6	261.9	262.4	262.6	263.0	263.4	263.8	264.1	264.4	264.8	265.2	265.5	265.8
38	262.6	262.9	263.3	263.7	264.1	264.4	264.7	265.1	265.5	265.9	266.2	266.5	266.9	267.3	267.6	267.9	268.3	268.7	269.1	269.4
39	266.0	266.4	266.8	267.2	267.5	267.9	268.2	268.6	268.9	269.3	269.7	270.0	270.4	270.8	271.2	271.5	271.8	272.2	272.6	272.9
40	269.4	269.8	270.2	270.6	270.9	271.3	271.7	272.0	272.4	272.8	273.1	273.5	273.9	274.3	274.6	274.9	275.3	275.7	276.1	276.4
41	272.8	273.2	273.5	273.9	274.3	274.7	275.0	275.4	275.8	276.2	276.5	276.9	277.2	277.6	278.0	278.3	278.7	279.1	279.5	279.8
42	276.1	276.5	276.9	277.3	277.6	278.0	278.4	278.7	279.1	279.5	279.8	280.2	280.6	281.0	281.4	281.7	282.1	282.5	282.9	283.2
43	279.3	279.7	280.1	280.5	280.9	281.3	281.6	282.0	282.4	282.8	283.1	283.5	283.9	284.3	284.7	285.0	285.4	285.8	286.2	286.5
44	282.6	282.9	283.4	283.8	284.2	284.6	284.9	285.3	285.7	286.1	286.4	286.8	287.2	287.6	288.0	288.3	288.7	289.1	289.5	289.9
45	285.8	286.2	286.6	286.9	287.4	287.8	288.1	288.5	288.9	289.3	289.7	290.1	290.5	290.9	291.3	291.6	291.9	292.4	292.8	293.1
46	288.9	289.3	289.7	290.1	290.5	290.9	291.3	291.7	292.1	292.5	292.8	293.3	293.7	294.1	294.5	294.8	295.2	295.6	296.0	296.4
47	292.1	292.5	292.9	293.3	293.7	294.1	294.5	294.9	295.3	295.7	296.0	296.5	296.9	297.3	297.7	298.0	298.4	298.9	299.3	299.6
48	295.1	295.5	295.9	296.4	296.8	297.2	297.6	297.9	298.4	298.8	299.2	299.6	299.9	300.4	300.8	301.2	301.6	301.9	302.4	302.8
49	298.2	298.6	299.0	299.5	299.9	300.3	300.7	301.1	301.5	301.9	302.3	302.7	303.1	303.5	303.9	304.3	304.7	305.1	305.6	305.9
50	301.2	301.6	302.1	302.5	302.9	303.3	303.7	304.1	304.5	304.9	305.3	305.8	306.2	306.6	307.0	307.4	307.8	308.2	308.6	309.0
51	304.2	304.6	305.1	305.5	305.9	306.3	306.7	307.1	307.6	307.9	308.3	308.8	309.2	309.6	310.1	310.4	310.8	311.3	311.7	312.1
52	307.2	307.6	308.1	308.5	308.9	309.4	309.7	310.1	310.6	311.0	311.4	311.8	312.2	312.7	313.1	313.5	313.9	314.3	314.8	315.1
53	310.1	310.6	311.0	311.4	311.9	312.3	312.7	313.1	313.5	313.9	314.4	314.8	315.2	315.7	316.1	316.5	316.9	317.3	317.8	318.1
54	313.0	313.5	313.9	314.3	314.8	315.2	315.6	316.0	316.5	316.9	317.3	317.7	318.2	318.6	319.1	319.4	319.9	320.3	320.7	321.1
55	315.9	316.4	316.8	317.3	317.7	318.1	318.5	318.9	319.4	319.8	320.2	320.7	321.1	321.6	322.0	322.4	322.8	323.3	323.7	324.1
56	318.8	319.2	319.7	320.1	320.6	321.0	321.4	321.8	322.3	322.7	323.1	323.6	324.0	324.5	324.9	325.3	325.7	326.2	326.6	327.0
57	321.6	322.1	322.5	322.9	323.4	323.9	324.3	324.7	325.2	325.6	326.0	326.5	326.9	327.4	327.8	328.2	328.7	329.1	329.6	329.9
58	324.4	324.9	325.4	325.8	326.3	326.7	327.1	327.6	328.0	328.5	328.9	329.3	329.8	330.2	330.7	331.1	331.5	331.9	332.4	332.8
59	327.2	327.7	328.1	328.6	329.1	329.5	329.9	330.4	330.8	331.3	331.7	332.1	332.6	333.0	333.5	333.9	334.4	334.8	335.3	335.7
60	329.9	330.4	330.9	331.4	331.8	332.3	332.6	333.2	333.6	334.1	334.5	334.9	335.4	335.9	336.3	336.7	337.2	337.6	338.1	338.5
61	327.7	333.2	333.6	334.1	334.6	335.1	335.4	335.9	336.4	336.8	337.2	337.7	338.2	338.6	339.1	339.5	339.9	340.4	340.9	341.3
62	335.4	335.9	336.4	336.8	337.3	337.8	338.2	338.6	339.1	339.6	339.9	340.5	340.9	341.4	341.9	342.3	342.8	343.2	343.7	344.1
63	338.1	338.6	339.1	339.5	340.0	340.5	340.9	341.4	341.8	342.3	342.7	343.2	343.7	344.1	344.6	345.0	345.5	345.9	346.5	346.8
64	340.8	341.3	341.8	342.2	342.7	343.2	343.6	344.1	344.6	345.0	345.4	345.9	346.4	346.9	347.4	347.8	348.2	348.7	349.2	349.6
65	343.4	343.9	344.4	344.9	345.4	345.9	346.3	346.7	347.2	347.7	348.1	348.6	349.1	349.6	350.1	350.5	350.9	351.4	351.9	352.3
66	346.1	346.6	347.1	347.5	348.0	348.5	348.9	349.4	349.9	350.4	350.8	351.3	351.8	352.3	352.7	352.3	353.6	354.1	354.6	355.0
67	348.7	349.2	349.7	350.2	350.6	351.1	351.5	352.0	352.5	353.0	353.4	353.9	354.4	354.9	355.4	355.8	356.3	356.8	357.3	357.7
68	351.3	351.8	352.3	352.8	353.3	353.8	354.2	354.7	355.2	355.6	356.1	356.6	357.1	357.5	358.0	358.5	358.9	359.4	359.9	360.4
69	353.9	354.4	354.9	355.4	355.9	356.4	356.8	357.3	357.8	358.3	358.7	359.2	359.7	360.2	360.7	361.1	361.6	362.1	362.6	363.0
70	356.4	356.9	357.4	357.9	358.4	358.9	359.4	359.9	360.4	360.9	361.3	361.8	362.3	362.8	363.3	363.7	364.2	364.7	365.2	365.6
71	358.9	359.5	359.9	360.5	360.9	361.5	361.9	362.4	362.9	363.4	363.8	364.3	364.8	365.4	365.9	366.3	366.8	367.3	367.8	368.2
72	361.5	361.9	362.5	362.9	363.5	364.0	364.4	364.9	365.4	365.9	366.4	366.9	367.4	367.9	368.4	368.8	369.4	369.9	370.4	370.8
73	363.9	364.5	364.9	365.5	366.0	366.5	366.9	367.5	367.9	368.5	368.9	369.4	369.9	370.5	370.9	371.4	371.9	372.4	372.9	373.4
74	366.4	366.9	367.5	367.9	368.5	369.0	369.5	369.9	370.5	371.0	371.4	371.9	372.5	372.9	373.5	373.9	374.4	374.9	375.5	375.9
75	368.9	369.4	369.9	370.5	370.9	371.5	371.9	372.5	372.9	373.5	373.9	374.5	374.9	375.5	376.0	376.5	376.9	377.5	378.0	378.4
76	371.4	371.9	372.4	372.9	373.5	374.0	374.4	374.9	375.4	376.0	376.4	376.9	377.5	378.0	378.5	378.9	379.5	380.0	380.5	380.9
77	373.8	374.3	374.9	375.4	375.9	376.4	376.9	377.4	377.9	378.5	378.9	379.4	379.9	380.5	381.0	381.4	381.9	382.5	383.0	383.5
78	376.2	376.8	377.3	377.8	378.4	378.9	379.3	379.9	380.4	380.9	381.4	381.9	382.4	382.9	383.5	383.9	384.5	384.9	385.5	385.9
79	378.6	379.2	379.7	380.2	380.8	381.3	381.7	382.3	382.8	383.3	383.8	384.3	384.9	385.4	385.9	386.4	386.9	387.4	387.9	388.4
80	381.0	381.6	382.1	382.6	383.2	383.7	384.1	384.7	385.2	385.8	386.2	386.7	387.3	387.8	388.3	388.8	389.3	389.9	390.4	390.9
82	385.7	386.3	386.8	387.4	387.9	388.5	388.9	389.5	389.9	390.5	390.9	391.5	392.1	392.6	393.2	393.6	394.2	394.7	395.3	395.7
84	390.4	390.9	391.5	392.1	392.6	392.3	393.6	394.2	394.7	395.3	395.7	396.3	396.8	397.4	397.9	398.4	398.9	399.5	400.0	400.5
86	395.1	395.6	396.2	396.7	397.3	397.9	398.3	398.9	399.4	399.9	400.5	401.0	401.6	402.1	402.7	403.1	403.7	404.3	404.8	405.3
88	399.6	400.2	400.8	401.3	401.9	402.4	402.9	403.5	404.0	404.6	405.1	405.6	406.2	406.8	407.3	407.8	408.4	408.9	409.5	409.9
90	404.1	404.7	405.3	405.8	406.4	406.9	407.5	408.0	408.6	409.2	409.6	410.2	410.8	411.4	411.9	412.4	412.9	413.5	414.1	414.6
92	408.6	409.2	409.8	410.3	410.9	411.5	411.9	412.6	413.1	413.7	414.2	414.8	415.3	415.9	416.5	416.9	417.5	418.1	418.7	419.2
94	413.0	413.6	414.2	414.8	415.3	415.9	416.4	416.9	417.6	418.1	418.6	419.2	419.8	420.4	420.9	421.4	422.0	422.6	423.2	423.7
96	417.4	417.9	418.6	419.2	419.7	420.3	420.8	421.4	421.9	422.6	423.1	423.7	424.3	424.8	424.5	425.9	426.5	427.1	427.7	428.2
98	421.7	422.3	422.9	423.5	424.1	424.7	425.2	425.8	426.3	426.9	427.4	428.0	428.6	429.2	429.8	430.3	430.9	431.5	432.1	432.6
100	426.0	426.6	427.2	427.8	428.4	429.0	429.5	430.1	430.7	431.3	431.8	432.4	433.0	433.6	434.2	434.7	435.3	435.9	436.5	437.0

NOTE: Values given in body of table are products of the square roots of the static and differential pressures in lb. per sq. in., abs., and inches of water, respectively.

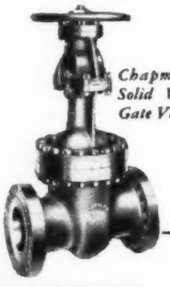
Absolute pressures are based on atmospheric pressure of 15 lb. per sq. in.

Table has been condensed to serve field men in approximating meter readings, intermediate readings for accurate measurements may be obtained from pressure extension books, usually available in district offices.

AN OLD HAND
AT
NEW REFINING PROCESSES
. . . that call for special valve-designs

In the development of today's widely used refinery processes . . . including production of synthetic rubbers . . . Chapman has been one of the chief reliances of the refining industries in meeting new requirements for valves.

Through many years of experience, refinery researchists have learned that Chapman's laboratory technicians, designers, and field engineers can always be counted on for 100% co-operation . . . that Chapman has invaluable facilities for producing special alloy steels . . . and the Chapman's solid grounding of practical experience in pioneering new processes is a powerful aid to progress.



Chapman 900-lb. Solid Wedge Steel Gate Valve.

Are *you* taking full advantage of Chapman co-operation and "know-how"? If not, let's talk it over, and see how we can help.

The **CHAPMAN VALVE**
MANUFACTURING COMPANY
INDIAN ORCHARD, MASSACHUSETTS

SOLUTION OF WEYMOUTH'S FORMULA FOR GAS FLOW IN LARGE CAPACITY LINES

Formula:

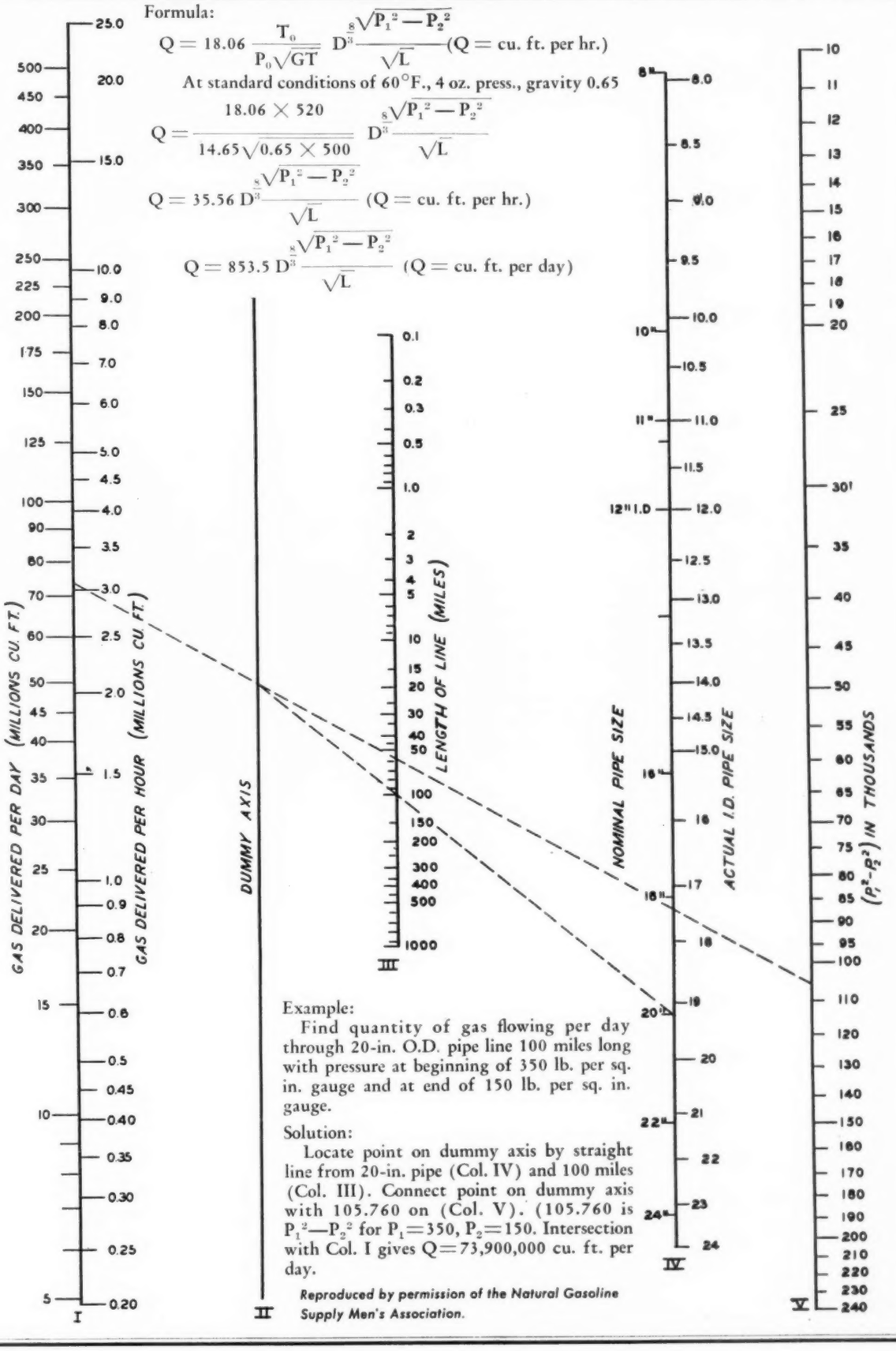
$$Q = 18.06 \frac{T_0}{P_0\sqrt{GT}} D^{\frac{8}{3}} \frac{\sqrt{P_1^2 - P_2^2}}{\sqrt{L}} \quad (Q = \text{cu. ft. per hr.})$$

At standard conditions of 60°F., 4 oz. press., gravity 0.65

$$Q = \frac{18.06 \times 520}{14.65\sqrt{0.65 \times 500}} D^{\frac{8}{3}} \frac{\sqrt{P_1^2 - P_2^2}}{\sqrt{L}}$$

$$Q = 35.56\, D^{\frac{8}{3}} \frac{\sqrt{P_1^2 - P_2^2}}{\sqrt{L}} \quad (Q = \text{cu. ft. per hr.})$$

$$Q = 853.5\, D^{\frac{8}{3}} \frac{\sqrt{P_1^2 - P_2^2}}{\sqrt{L}} \quad (Q = \text{cu. ft. per day})$$



Example:

Find quantity of gas flowing per day through 20-in. O.D. pipe line 100 miles long with pressure at beginning of 350 lb. per sq. in. gauge and at end of 150 lb. per sq. in. gauge.

Solution:

Locate point on dummy axis by straight line from 20-in. pipe (Col. IV) and 100 miles (Col. III). Connect point on dummy axis with 105.760 on (Col. V). (105.760 is $P_1^2 - P_2^2$ for $P_1 = 350$, $P_2 = 150$. Intersection with Col. I gives Q = 73,900,000 cu. ft. per day.

Reproduced by permission of the Natural Gasoline Supply Men's Association.

FOR 25 YEARS NO-OX-ID has been THE *Accepted* RUST PREVENTIVE

To New Men in Pipe Laying Crews...

Experienced pipe laying men have worked with NO-OX-ID so long that they know all about it. They know that contact with it day after day does not cause the slightest discomfort to hands or other exposed parts of the body. They know too that lines have been protected for years with only the original application. But now many of these men have joined the Army, Navy, or Marines, and new men are taking their places. It is to these new men that this memo is addressed.

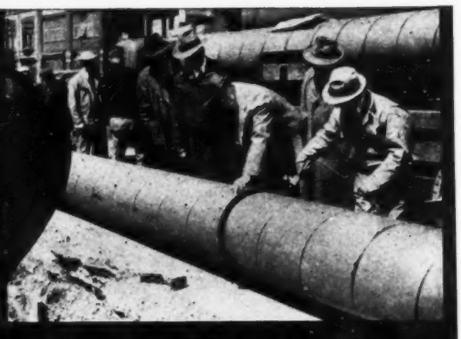
NO-OX-ID prevents rust two ways: mechanically by excluding moisture and oxygen, and chemically by inhibiting any underfilm corrosion which may be present.

A combination of NO-OX-ID and NO-OX-IDized Wrappers provides complete protection and can be applied rapidly and easily by stationary machine, traveling machine, or by hand.

Tell us your problem... we will recommend the proper procedure to meet the very conditions under which your work is being done. We'll furnish specifications covering recommended type of material and the most economical method of application.

NO-OX-ID IRON-OX RUST TRADE MARK
The Original Rust Preventive

Dearborn CHEMICAL COMPANY
Dept. L, 310 S. Michigan Ave., Chicago
New York • Los Angeles • Toronto



Testing coating at high voltage for pin holes or voids before lowering in.

Surprising how quickly the work can be done by hand coating with NO-OX-ID and hand applying NO-OX-IDized Wrapper.

When service lines under city streets are treated with NO-OX-ID, they are down to stay.

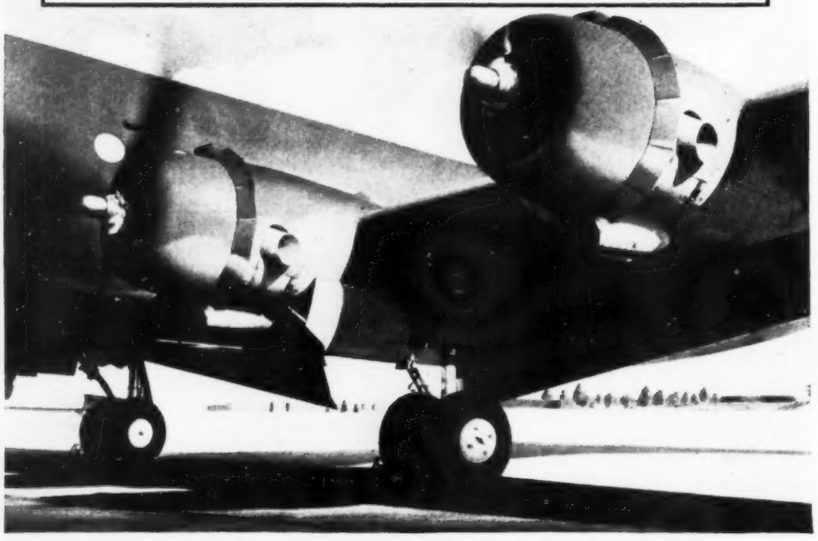
NO-OX-IDized Wrapper being applied with traveling type coating and wrapping machine.

SQUARES* OF WHOLE NUMBERS

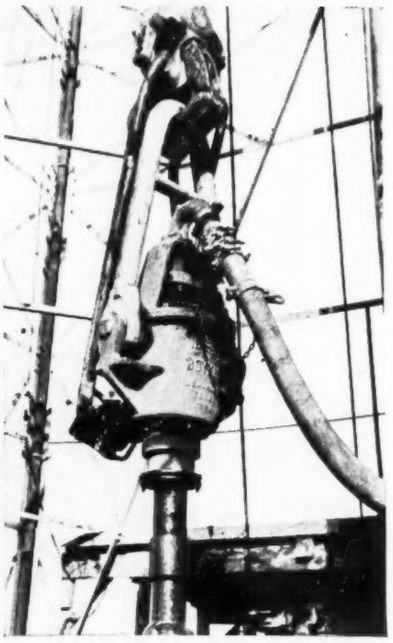
	0	1	2	3	4	5	6	7	8	9
1500	2.250	2,253	2,256	2,259	2,262	2,265	2,268	2,271	2,274	2,277
1510	2,280	2,283	2,286	2,289	2,292	2,295	2,298	2,301	2,304	2,307
1520	2,310	2,313	2,316	2,320	2,323	2,326	2,329	2,332	2,335	2,338
1530	2,341	2,344	2,347	2,350	2,353	2,356	2,359	2,362	2,365	2,369
1540	2,372	2,375	2,378	2,381	2,384	2,387	2,390	2,393	2,396	2,399
1550	2,403	2,406	2,409	2,412	2,415	2,418	2,421	2,424	2,427	2,430
1560	2,434	2,437	2,440	2,443	2,446	2,449	2,452	2,455	2,459	2,462
1570	2,465	2,468	2,471	2,474	2,447	2,481	2,484	2,487	2,490	2,493
1580	2,496	2,500	2,503	2,506	2,509	2,512	2,515	2,519	2,522	2,525
1590	2,528	2,531	2,534	2,538	2,541	2,544	2,547	2,550	2,554	2,557
1600	2,560	2,563	2,566	2,570	2,573	2,576	2,579	2,582	2,586	2,589
1610	2,592	2,595	2,599	2,602	2,605	2,608	2,611	2,615	2,618	2,621
1620	2,624	2,628	2,631	2,634	2,637	2,641	2,644	2,647	2,650	2,654
1630	2,657	2,660	2,663	2,667	2,670	2,673	2,676	2,680	2,683	2,686
1640	2,690	2,693	2,696	2,699	2,703	2,706	2,709	2,713	2,716	2,719
1650	2,723	2,726	2,729	2,732	2,736	2,739	2,742	2,746	2,749	2,752
1660	2,756	2,759	2,762	2,766	2,769	2,772	2,776	2,779	2,782	2,786
1670	2,789	2,792	2,796	2,799	2,802	2,806	2,809	2,812	2,816	2,819
1680	2,822	2,826	2,829	2,832	2,836	2,839	2,843	2,846	2,849	2,853
1690	2,856	2,859	2,863	2,866	2,870	2,873	2,876	2,880	2,883	2,887
1700	2,890	2,893	2,897	2,900	2,904	2,907	2,910	2,914	2,917	2,921
1710	2,924	2,928	2,931	2,934	2,938	2,941	2,945	2,948	2,952	2,955
1720	2,958	2,962	2,965	2,969	2,972	2,976	2,979	2,983	2,986	2,989
1730	2,993	2,996	3,000	3,003	3,007	3,010	3,014	3,017	3,021	3,024
1740	3,028	3,031	3,035	3,038	3,042	3,045	3,049	3,052	3,056	3,059
1750	3,063	3,066	3,070	3,073	3,077	3,080	3,084	3,087	3,091	3,094
1760	3,098	3,101	3,105	3,108	3,112	3,115	3,119	3,122	3,126	3,129
1770	3,133	3,136	3,140	3,144	3,147	3,151	3,154	3,158	3,161	3,165
1780	3,168	3,172	3,176	3,179	3,183	3,186	3,190	3,193	3,197	3,201
1790	3,204	3,208	3,211	3,215	3,218	3,222	3,226	3,229	3,233	3,236
1800	3,240	3,244	3,247	3,251	3,254	3,258	3,262	3,265	3,269	3,272
1810	3,276	3,280	3,283	3,287	3,291	3,294	3,298	3,301	3,305	3,309
1820	3,312	3,316	3,320	3,323	3,327	3,331	3,334	3,338	3,342	3,345
1830	3,349	3,353	3,356	3,360	3,364	3,367	3,371	3,375	3,378	3,382
1840	3,386	3,389	3,393	3,397	3,400	3,404	3,408	3,411	3,415	3,419
1850	3,423	3,426	3,430	3,434	3,437	3,441	3,445	3,448	3,452	3,456
1860	3,460	3,463	3,467	3,471	3,474	3,478	3,482	3,486	3,489	3,493
1870	3,497	3,501	3,504	3,508	3,512	3,516	3,519	3,523	3,527	3,531
1880	3,534	3,538	3,542	3,546	3,549	3,553	3,557	3,561	3,565	3,568
1890	3,572	3,576	3,580	3,583	3,587	3,591	3,595	3,599	3,602	3,606
1900	3,610	3,614	3,618	3,621	3,625	3,629	3,633	3,637	3,640	3,644
1910	3,648	3,652	3,656	3,660	3,663	3,667	3,671	3,675	3,679	3,683
1920	3,686	3,690	3,694	3,698	3,702	3,706	3,709	3,713	3,717	3,721
1930	3,725	3,729	3,733	3,736	3,740	3,744	3,749	3,752	3,756	3,760
1940	3,764	3,767	3,771	3,775	3,779	3,783	3,787	3,791	3,795	3,799
1950	3,803	3,806	3,810	3,814	3,818	3,822	3,826	3,830	3,834	3,833
1960	3,842	3,846	3,849	3,853	3,857	3,861	3,865	3,869	3,873	3,877
1970	3,881	3,885	3,889	3,893	3,897	3,901	3,905	3,909	3,912	3,916
1980	3,920	3,924	3,928	3,932	3,936	3,940	3,944	3,948	3,952	3,956
1990	3,960	3,964	3,968	3,972	3,976	3,980	3,984	3,988	3,992	3,996

*Squares of numbers are expressed in thousands.

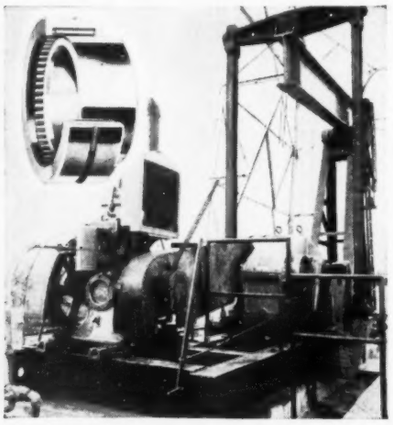
IN THE NEWS
WITH BANTAM BEARINGS



GIANT ENGINES KEEP THEM FLYING, furnishing smooth, unfailing power for America's fast-expanding air fleets. Many of the nation's speediest, most efficient bombers, fighters, transports, and cargo planes are powered by huge, air-cooled, radial engines that develop 2,000 horsepower. Among the many engineering features that contribute to the successful performance of these engines is the use of Bantam Needle Rollers to provide anti-friction bearing units of unusually light weight and small size in proportion to their load capacity.

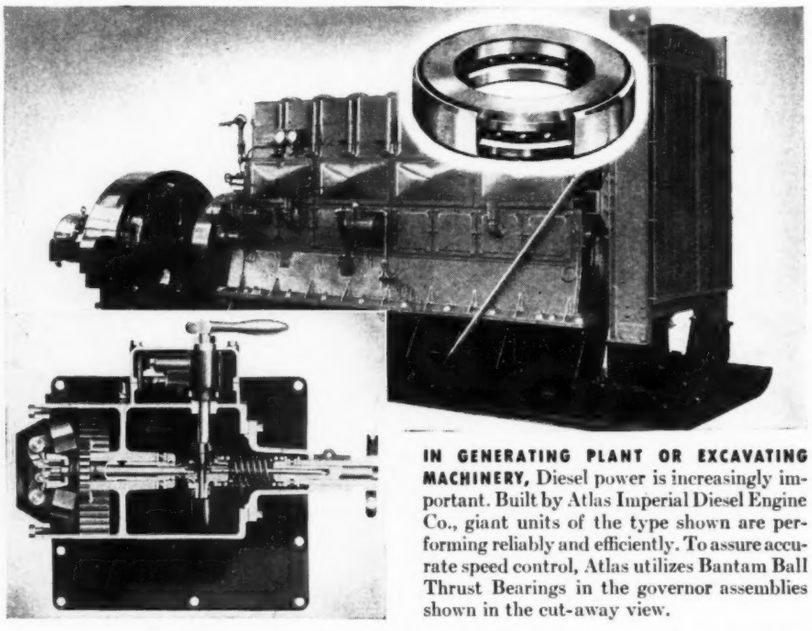


WELL DRILLING SPEEDS ARE FASTER, loads are heavier, depths are greater. 8-inch Oil-bath Rotary Swivels built by The International Derrick and Equipment Company embody in their design every feature and strength factor necessary in present-day drilling practice. Bantam Bearings provide a safe load capacity far above the most rigid requirements of the service, are a vital factor in the high performance standards of the equipment.



BACKBONE OF A COMBUSTION ENGINE is the crankshaft construction—and Weber Engine Company, after exhaustive studies, selected Bantam Quill Bearings for use on this vital part of their Vertical Gas Engines. Bantam Quill Bearings combine the advantages of anti-friction construction, high load capacity, small size, and ease of installation. For full details on this unusual bearing, write for Bulletin P-104.

BANTAM'S ENGINEERING COOPERATION is especially valuable in meeting new and unusual requirements. Bantam makes every major type of anti-friction bearing—straight roller, tapered roller, needle, and ball. Bantam engineers aid in the selection of the type that best suits your application—or design special bearings that meet your requirements. If you have a difficult bearing problem, TURN TO BANTAM.



IN GENERATING PLANT OR EXCAVATING MACHINERY, Diesel power is increasingly important. Built by Atlas Imperial Diesel Engine Co., giant units of the type shown are performing reliably and efficiently. To assure accurate speed control, Atlas utilizes Bantam Ball Thrust Bearings in the governor assemblies shown in the cut-away view.

BANTAM BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

BANTAM BEARINGS CORPORATION • SOUTH BEND • INDIANA

Running Tour

WITH MEN IN THE INDUSTRY

A. J. HOLLAND, assistant superintendent of production in the West Texas-New Mexico district for The Texas Company, has been transferred to Salem, Illinois. He will be assistant superintendent in that area under Superintendent W. C. KNEALE.

FRANK QUINLAN, Mt. Pleasant, Michigan, recently was appointed manager of the Victory Drilling Company.

W. H. STUEVE of the Oklahoma Gas and Electric Company, Oklahoma City, and well known in the petroleum industry, has assumed duties at Little Rock, Arkansas, as consultant for the War Emergency Pipe Line, Inc.

WILLIAM P. ANDREWS, vice-president of the Douglas Oil and Refining Company, Wilmington, California, has resigned to devote full time to the Comet Refining Company of which he is president.

GEORGE K. TAGGART, JR., general superintendent of Pantex Oil Company, has transferred his headquarters from Fort Worth, Texas, to Taft, Texas.

BENJAMIN ALVARADO, assistant chief of the Colombian Ministry of Mines and Petroleum, has been made chief of the National Geological Survey of Colombia.

J. P. MCCULLOUGH, assistant to the manager of foreign production department of The Texas Company, New York City, recently made a survey of operations in Venezuela and Colombia.

W. G. CORWIN, vice-president of the Colombian Petroleum Company, is back at his headquarters in New York City after inspecting the company's Barco Concession in Colombia.

TRUMAN BRANTON, production superintendent for Housh and Thompson, Houston, Texas, has been commissioned a first lieutenant in the Army Air Corps. He is stationed at Miami Beach, Florida.

FRANK HILBORN, who has been in Venezuela the last three years for the Magnolia Petroleum Company, has returned to his home in Electra, Texas.

JULIUS A. BERNINGHAUS, general manager of sales of the Organic Chemicals Division of Monsanto Chemical Company, St. Louis, Missouri, has been made general manager of the division, it is announced by EDGAR M. QUEENY, president. He succeeds JOHN W. LIVINGSTON, who resigned to become consulting engineer to the Rubber Reserve Company, the federal agency dealing with the provision of facilities for synthetic rubber production.

JOHN C. SLONNEGER, chief engineer of the Continental Supply Company, Dallas, Texas, recently discussed the subject of counterbalancing before the Seminole, Oklahoma, Chapter of the American Petroleum Institute.

C. D. MILLER has resigned as general superintendent of production for Barnsdall Oil Company, Tulsa, Oklahoma, to become vice-president in charge of production for the British American Oil Producing Company. He has been with Barnsdall 15 years. K. W. HALEY, who has been chief engineer and assistant superintendent of production, succeeds him at Barnsdall.

LEE HAUGEN, superintendent of the Ponca City, Oklahoma, refinery of the Cities Service Oil Company, has been transferred to the East Chicago, Indiana, refinery of the company.

FRANK H. SCHOUTEN, Fort Worth, Texas, district geologist for Stanolind Oil and Gas Company, has been placed in charge of geophysical activity of the company. He is succeeded by F. J. SCHEMPF.

KILBURN ADAMS, geologist for The Texas Company at Tulsa, Oklahoma, has been given a leave of absence to direct a glider pilot school for the government at Lamesa, Texas.

W. L. JAMES has resumed his duties as purchasing agent for the Stanolind Oil and Gas Company at Tulsa, Oklahoma. He has been in Washington as assistant director in charge of commodity procurement specialists.

CARL MEYER, formerly with the Continental Supply Company, is now with the War Production Board, making his headquarters at Dallas, Texas.

JACK HELLINGHAUSEN has taken a position as production engineer with the Atlantic Refining Company.

W. H. BENDUHN, president of the Buda Engine and Equipment Company of Texas, Dallas, has been named to the War Production Board at Washington.

T. M. BOHEN, president of Whitehead Metal Products Company, Inc., announces that ELMER W. SILVER, secretary, has been elected treasurer of the company, succeeding the late WILLIAM L. RIANHARD, who died July 24. Silver will continue as secretary, to which office he was elected last March.

CLINTON OWSLEY has been named to succeed DR. F. V. L. PATTEN as chief of the Oil and Gas Division of the Texas Railroad Commission. Owsley has been director of production for the commission. Patten, on August 1, became assistant director of the division of reserves of the Office of Petroleum Coördinator. J. K. BAUMEL, chief enforcement officer, succeeds Owsley as director of production.

J. A. WOLFE, of the Summit Drilling Corporation, Tulsa, Oklahoma, has been commissioned a captain in the Air Corps and assigned to Miami Beach, Florida. Wolfe came out of the first World War as a sergeant.

W. C. KINSOLVING, general and operating superintendent of the Sun Pipe Line Company, Beaumont, Texas, has been named assistant director of transportation by the Office of Petroleum Coördinator.

GRADY H. VAUGHN, who has been in charge of District 3 for the Office of Petroleum Coördinator, was transferred to Washington, D. C., August 1 to assume a new post with OPC Deputy Coördinator RALPH K. DAVIES, in making the announcement, said Vaughn was being transferred to Washington in connection with the nation-wide survey of the possibilities of reclaiming oil-field equipment for more important war uses in the petroleum industry. D. E. BUCHANAN of Tulsa, Oklahoma, was appointed director in charge of the District 3 office to succeed Vaughn. E. O. BUCK of Houston, Texas, succeeds Vaughn as district production director. He has been serving as assistant production director for the area.

A. H. FLAHERTY, veteran drilling contractor and an official of Krupp-Flaherty Oil Corporation, died recently at Midland, Texas. He was 56 years of age.

ROBERT G. GOUGH, division petroleum engineer at Fort Worth, Texas, for Continental Oil Company, has been made superintendent for the Panhandle District with headquarters at Borger, Texas. He succeeds W. E. BEYHAN, who has been assigned to special duties.

GENERAL HORTA BARBOSA, chief of Brazil's national petroleum council, is in the United States inspecting methods and installations of the oil industry with a view to preparing his country to meet petroleum industry emergencies should Brazil actively enter the war. His trip is being made at the invitation of the State Department of the United States.

MR. and MRS. RANDALL BARRETT are the parents of an 8½-pound boy born August 3 at Dallas, Texas. Barrett is circulation manager of *The Petroleum Engineer*. The youngster has been named Jon Randall.

EDWARD L. CARTER has been appointed manager of the export divsion of W. C. Norris, Manufacturer, Inc., Tulsa, Oklahoma. His office is Room 1809 R.C.A. Building, 30 Rockefeller Plaza, New York, New York.

NORTH BIGBEE, for the last three years connected with the Texas Mid-Continent Oil and Gas Association at Dallas, Texas, has been commissioned a first lieutenant in the Army Air Corps.

ROBERT E. JENNINGS, independent operator of Dallas, Texas, has been commissioned a lieutenant commander in the Navy.

T. W. MCSPADDEN, drilling and production engineer with the Delta Drilling Company, Tyler, Texas, has resigned to enter the Army Air Corps.

BRUCE K. BROWN, of Chicago, Illinois, has been appointed an assistant deputy coördinator in the office of the Petroleum Coördinator for War. Brown will serve as a general assistant to RALPH K. DAVIES, deputy petroleum coördinator, particularly in the fields of refining and marketing. His appointment to this position follows seven months of special service with the Office of Petroleum Coördinator as a consultant on aviation gasoline. Prior to entering the oil business in 1929, Brown had a decade of experience as a research chemist and as a lawyer in the electro-chemical and fermentation fields. Joining Standard Oil Company (Indiana) as its general patent attorney, he later was placed in charge of petroleum research and development for that organization and became a member of the board of directors, from which position he recently resigned in order to make his services available to the Government for the duration.

LESTER M. GOLDSMITH

LESTER M. GOLDSMITH, vice-president and chief engineer of the Atlantic Pipe Line Company, and chief engineer of the Atlantic Refining Company, recently received an honorary degree of Doctor of Science from Drexel Institute of Technology, Philadelphia, Pennsylvania, from which institute he graduated in 1914.

FRANK H. DOTTERWEICH, head of the Division of Natural Gas Engineering of the Texas College of Arts and Industries, Kingsville, Texas, has been granted a temporary leave of absence to serve as research specialist in the Natural Gas and Gasoline Division in the Office of Petroleum Coördinator for War at Washington, D. C.

DAVID G. HAWTHORN of the Amerada Petroleum Corporation, Tulsa, Oklahoma, is now on special duty at the Naval Ordnance Laboratory at the Navy Yards in Washington, D. C.

JOHN HEMPHILL, engineer for Sinclair Prairie Oil Company in the Glenpool-Kiefer area of Oklahoma, has been made a lieutenant, junior grade, in the Ordnance Corps of the United States Navy. He left recently for Fort Schuyler.

R. H. MCLEMORE, formerly with the Sun Oil Company, Dallas, Texas, and now a major in the Army Air Corps, recently was transferred from Fort Logan, Colorado, to Pasadena, California, where he is on special duty at the California Institute of Technology.

B. B. MORTON, Development and Research Division of the International Nickel Company, Inc., New York, New York, gave a talk August 6 before the Annual Meeting of the California Natural Gasoline Association on "The Application of Corrosion Resistant Alloys to Natural Gasoline Plants."

S. H. MORTENSEN, engineer-in-charge of a-c. design for 10 years, has been appointed chief electrical engineer of the Allis-Chalmers Manufacturing Company plants at West Allis, Cincinnati, Boston, and Pittsburgh. Entering the employ of Allis-Chalmers at the Norwood Works in 1905, Mortensen was transferred to Milwaukee as an electrical draftsman three years later. There he successively became design engineer for d-c. machines, design engineer of rotating synchronous machines, and in 1932 engineer-in-charge of alternating current design.

DAN C. HUNGERFORD has resigned as vice-president and director of the Elastic Stop Nut Corporation, Union, New Jersey. He joined the corporation in 1936 as field engineer and, 18 months later, was made chief engineer. In January, 1940, he was elected to the board of directors and, in July of the same year, was made vice-president in charge of engineering. He was placed in charge of the corporation's sales and advertising activities in 1941.

BURTON L. BOYE, president of the Asphalt Institute from 1933 to 1938, and formerly in charge of the asphalt department of the Standard Oil Company of New York, died at Summit, New Jersey, recently.

BILL DAVIS, at one time with the American Liberty Pipe Line Company, Dallas, Texas, and later with Darling Valve Company, Williamsport, Pennsylvania, is now in the Air Corps and recently was transferred to California.

HARLEY T. PRICE has been appointed direct factory representative for the Mid-Continent area by the Murphy Diesel Company, Milwaukee, Wisconsin. He is making his headquarters at 412 West Fourth Street, Tulsa, Oklahoma, and will devote his entire time to sales and giving assistance on Diesel engine applications. Price is a native Oklahoman and a veteran of the first World War.

SPANG

SEAMLESS

serves up

"Liquid Ammunition"!

OIL . . . for lubrication . . . for temperature-resisting greases . . . for high octane gasoline . . . for synthetic rubber . . . is truly the "liquid ammunition" of mechanized warfare . . . and a resource largely dependent upon pipe.

That's why the uniformity, dependability, and rugged durability of Spang Seamless Oil Country Pipe is playing such a vital part in maintaining a continuous supply of oil to the United Nations.

Sold by SPANG CHALFANT, INC.
GENERAL OFFICES: GRANT BUILDING, PITTSBURGH, PA.
Sales Offices: Boston - New York - Philadelphia - Pittsburgh - Atlanta - Chicago
St. Louis - Tulsa - Houston - Denver - San Francisco - Los Angeles

LAUGH WITH BARNEY

Lawyer: Then your husband, I take it, is elderly.

Fair Client: Elderly? Why, he's so old he gets winded playing chess.

* * *

She was the type that could best be described as having a beautiful profile all the way down.

* * *

First Co-ed: Jimmy is grand but I think all men are trying sometimes.

Second Co-ed: All the time, dearie, all the time.

* * *

Overheard at the bus depot:

"The war'll be over in six weeks."

"What makes you think that?"

"Well the army took my brother this week and he never in his life held a job longer than six weeks."

* * *

"Do you know your wife is telling around that you can't keep her in clothes?"

"That's nothing. I bought her a home and I can't keep her in that either."

* * *

If you want to forget all your other troubles, wear tight shoes.

* * *

"Say, pa."

"Well, my son?"

"I took a walk through the cemetery today and read the inscriptions on the tombstones."

"Well, what about it?"

"Where are all the wicked people buried."

* * *

Missus: Well, you can't say I ran after you.

Mister: No and neither does a mouse trap run after mice; but it catches 'em just the same.

* * *

Maid: The installment man is here again, Ma'am.

Madam (resignedly): Tell him to take a chair.

* * *

"I don't know what to make of my husband," said the cannibal queen.

"Have you tried this recipe?" said her dearest friend.

* * *

And when I die, please bury me
'Neath a ton of sugar, under a rubber tree;
Lay me to rest in a new auto machine
And water my grave with good gasoline.

"When were you born?" asked the sergeant of the recruit.

"December, 1917," replied the man.

"Ah," mused the sergeant, "I well recall that winter. It was bitterly cold."

"I'll say it was cold," said the recruit. "I was brought by a penguin. The stork couldn't make it."

* * *

Customer: Young man, what have you in the shape of automobile tires?

Salesman: Well, sir, I can give you funeral wreaths, life preservers and doughnuts.

* * *

Counsel (to police witness): But, if a man is on his hands and knees in the middle of the road, that does not prove he is drunk.

Policeman: No, sir, it doesn't. But this one was trying to roll up the white line.

* * *

"You know, I think that new recruit used to be a bookkeeper."

"Why?"

"Well, every time he stands at ease he tries to put his rifle behind his ear."

* * *

"Madam, is that dog of yours house-broken?"

"House-broken! Gracious me — of course he's house-broken. I have to take a table leg and a bit of carpet along when I take him for a walk."

* * *

A young R.A.F. officer stationed somewhere in Egypt was flying near the Great Pyramid, carrying out exercises in navigation and discovering his geographical position with a sextant.

After a series of involved and confused calculations, he turned suddenly to his pilot and said:

"Take your hat off."

"Why?" asked the pilot.

"Because, according to my calculations, we are now inside St. Paul's Cathedral."

* * *

Last week we heard about the old Negro who was taking a civil service examination for the job of mail carrier. One of the questions was: "How far is it from the earth to the sun?"

The old darky looked frightened and exclaimed: "If you all is gwin ter put me on that route, Ize resignin' befo' I begins."

A lawyer was always lecturing his office boy, whether he needed it or not. One day he heard this conversation between the boy and one employed next door:

"How much does he pay you?" asked the latter.

"I get $5,000 a year," replied the lawyer's boy; "ten dollars a week in cash and the rest in legal advice."

* * *

A husband drew up his chair beside his wife's sewing machine.

"Don't you think you're running too fast?" he asked. "Look out! You'll sew the wrong seam! Mind that corner, now! Slow down, watch your finger! Steady"

"What's the matter with you, John?" said his wife, alarmed. I've been running this machine for years!"

"Well, dear, I thought you might like me to help you, since you help me drive the car."

* * *

Elsie: What kind of husband would you advise me to get, Grandma?

Grandma: You just leave husbands alone and get yourself a single man.

* * *

The boss plumber was absorbed in the intricacies of the job he was working on, apparently oblivious to his new apprentice who stood looking on.

"Say," inquired the lad, "do you charge for my time?"

"Sure, I'm gonna put it in the bill," was the reply.

"But I haven't done anything," the helper protested.

The plumber gazed at him a moment in silent pity. Then he turned to make a final inspection of the finished job by the light of the candle. Satisfied that all was okay, he handed the stub of the candle to the helper and said, witheringly, "All right kid, if you gotta be so conscientious, blow that out!"

* * *

"Jones has eleven children."

"Gosh! He's gone stork mad, hasn't he?"

* * *

The modern Miss asked the pro if he could tell her how to play golf.

Pro: Sure, it's easy enough. All you do is smack the pill and then walk.

Modern Miss: How interesting. Just like some auto rides I've been on.

* * *

Our grandmothers believed that there was a destiny which shaped our ends, but the modern girls place more faith in girdles.

General Headings

Unit No. A-12

Subject

BAKER MODEL "B" CASING CENTRALIZER

BAKER OIL TOOLS, INC.

Main Office and Factory:
6000 So. Boyle Ave., Box 127, Vernon Station, Los Angeles, Calif.
Central Division Office and Factory:
6023 Navigation Blvd., Box 3048, Houston, Texas
Export Sales Office:
19 Rector Street, New York, N. Y.

Index: 250.1
Date: August, 1942
Page: 1 of 1 p.

Field Practice of Centering Casing to Insure a Better Cement Job

The use of Casing Centralizers to provide a more uniform annulus between the casing and the wall of the hole at critical cementing points, is becoming standard practice in many territories. Field results have indicated that the uniform annulus thus provided for the slurry is an important factor in minimizing channeling and in securing a successful *first time* cement job.

Field results have also indicated that the Baker Model "B" Casing Centralizer is one of the most efficient types of centering units yet devised. The effectiveness of Baker Casing Centralizers and their ability to stand up under severe operating conditions was ably demonstrated in a recent job performed in the Mid-Continent area, the essential details of which are given below.

In this particular well, three Baker Model "B" Casing Centralizers (in addition to a Baker Cement Wash-Down Whirler Float Shoe and a Baker Cement Float Collar) were placed on a string of 5½" casing that was to be landed in a 9200' hole. When the casing reached 7200', the engine broke down and it was impossible to raise or lower the string for nine hours, during which time, however, circulation was maintained. When the engine was repaired, it was found the pipe was stuck and oil was circulated to aid in its release. Ten days were spent attempting to loosen the string before it was finally pulled out of the hole.

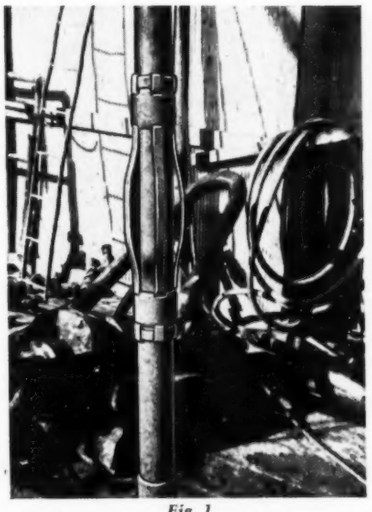


Fig. 1
Showing the excellent condition of one of the Baker Casing Centralizers on this job after being run in to 7200' and then pulled from hole.

The three Baker Casing Centralizers were found to be in just as good condition as when they were originally run in (see Fig. 1). Leaving these three original Baker Casing Centralizers on the pipe, a fourth Baker Centralizer, which had unintentionally been left off the string on the first run, was then added, and the casing re-run to bottom (9200') without difficulty.

The reason why Baker Casing Centralizers can "take it" is because of their sturdy construction and unique operating principle . . . details of which are given below. (Also, see pages 248 and 249 of the 1942 Baker or Composite Catalog.)

OPERATING DETAILS ★ Baker Model "B" Casing Centralizer

The Baker Casing Centralizer, which in normal position is slightly larger than the casing or hole in which it is to run, is attached by merely slipping it on the casing, positioning it at the desired point, and plug-welding the two Stop Rings. Due to the method of construction, when running casing equipped with a Baker Model "B" Casing Centralizer, there is no tendency of the Centralizer to revolve as it goes down the hole. Details of the operation of the Baker Model "B" Casing Centralizer are shown in the accompanying illustrations. Note that whether the casing is being lowered or raised, the Centralizer is always PULLED through the casing or past a restriction in the open hole . . . never PUSHED. This pulling action eliminates any possibility of the Centralizer Springs being distorted or damaged while landing the casing. One of the most important features is the fact that the Springs of the Baker Casing Centralizer always compress uniformly, tending to effectively center the casing in the hole regardless of the extent to which the Centralizer Springs are compressed.

With ordinary types of Centralizers which have the Springs rigidly mounted on Rings, the hazard of damaging the Springs and impairing the centering efficiency of such units will be obvious to experienced operators.

Fig. 2
Showing Baker Casing Centralizer Attached to Casing Before Running-in.

(1) Stop Rings are positioned so that they engage the forged hooks on the ends of the Springs.

(2) The Stop Rings are plug-welded to the casing.

(3) Note space between Collars and Stop Rings to permit travel when Springs are compressed and elongated.

(4) When lowering the casing, the lower Stop Ring engages the hooks on the lower ends of the Springs, PULLING the Centralizer through the hole (or casing) rather than pushing it through.

(5) When running through open hole and a restriction is encountered, the Centralizer Springs UNIFORMLY COMPRESS and elongate in an upward direction, moving the upper Collar upwardly toward the upper Stop Ring. (This upward movement is made possible by the initial space provided between the upper Collar and the Stop Ring. The space is sufficient to allow the Springs to be compressed to their fullest extent against the casing without engagement of the upper Collar with the upper Stop Ring.)

(6) Note that during the downward travel of the casing the upper Stop Ring is never in contact with either Collar or the upper hooked ends of the Springs so that the Ring is unable to exert any pushing force whatsoever on the Springs that would tend to buckle or distort them.

Fig. 3
Lowering Casing Equipped with a Baker Casing Centralizer. (When casing is raised, the action of the Centralizer is just the reverse as illustrated above, the unit being PULLED upward past the restriction by the contact of the upper Stop Ring with the hooked ends of the Springs.)

MACHINERY and EQUIPMENT

25-Ton Standard Speed Screw Jack

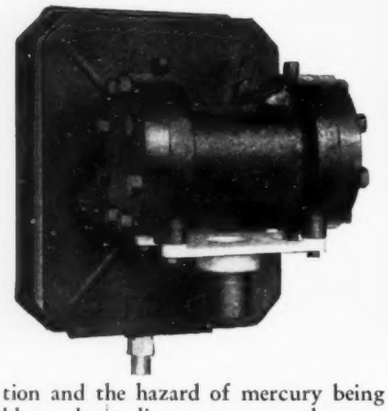
TEMPLETON, KENLY and Company, Chicago, Illinois, makers of Simplex Jacks, announce the addition of a 25-ton standard-speed, bevel-gear, ball-bearing screw jack, No. 7300.

Designed for heavy-duty lifting, lowering, and skidding work, the manufacturer states that the safe mechanical action, screw adjustment, and enclosed ratchet mechanism combined with both toe and cap lift make it a serviceable jack for all heavy industrial work.

Toe lift is a minimum of 11 in. from base, but jacks can be made with toe in any position to suit user's requirements, and the base design can be modified. No. 7300 is guaranteed to lift its full rated capacity of 25 tons on cap and 12½ tons on toe, has a full 6-in. lift, and weighs only 82 lb. complete.

Taylor Aneroid Manometer

THE absence of mercury or other liquid from the Taylor Aneroid Manometer, for flow or liquid level, developed by the Taylor Instrument Companies, Rochester, New York, removes the possibility of product contamination and the hazard of mercury being blown due to line surges or carelessness. Further advantages are that sealing liquids are rarely required and vital mercury is released for the war effort.



Replacing the stuffing box is a new torque tube assembly, which gives a completely closed system and is designed to eliminate friction and lubrication. This new assembly also does away with the lost time involved in maintenance, the manufacturer asserts. Friction, lost motion, and wear are further reduced by the absence of internal pivots and springs.

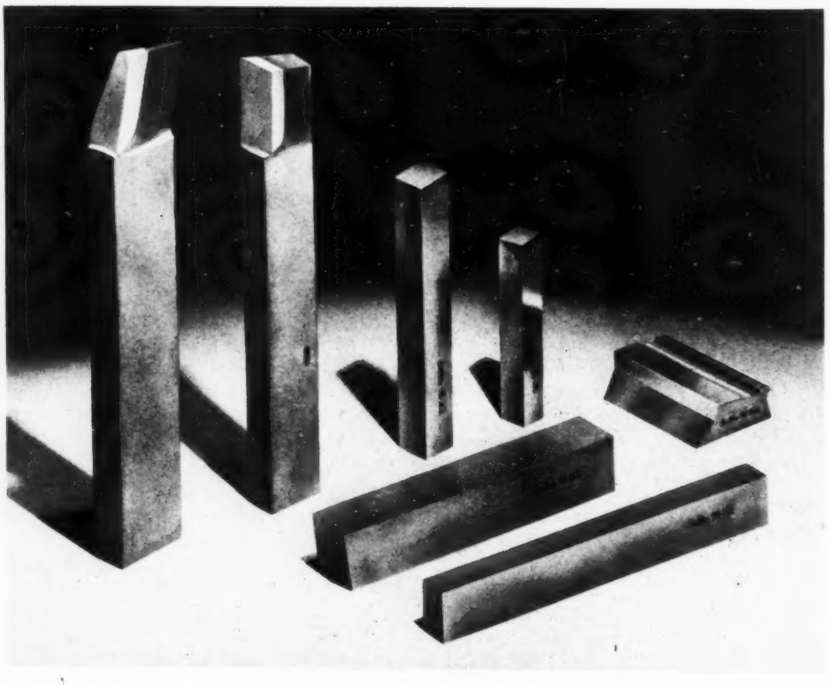
Metal bellows respond to the pressure variations and insure faster response under ordinary circumstances with immediate reaction to sudden changes in flow, it is stated. The sturdy bellows are built to withstand high over-range pressures without damage.

Under steady flow conditions the Taylor Aneroid Manometer is accurate within 1 percent of scale range, it is asserted. It is available for all types of indicating and recording meters and controllers and is supplied for standard ranges between 20 and 500 in. of water. The range can be changed right on the job by substituting precalibrated torque tubes.

For further information write the Taylor Instrument Companies, Rochester, New York.

"Stellite" Alloy for Machining Steel

"STELLITE" 98M2 tools are made of a new cobalt-chromium-tungsten alloy especially designed to increase the speed of machining steel in production shops. Developed as part of a long-range research program by Haynes Stellite Company in coöperation with Union Carbide and Carbon Research Laboratories, Inc., the new alloy represents another definite achievement in the field of metal-cutting tools, the manufacturer states.



The new tools machine steel at even higher cutting speeds than "Stellite" Star J-Metal or "2400" tools, with longer life between grinds, it is asserted. With 98M2 tools, heavy roughing cuts are being taken on steel turning jobs with coarse feeds—to get high rates of metal removal—yet tool life is long and economical, for the new alloy is well balanced in red hardness, edge strength, and toughness, it is further pointed out.

The new alloy tools are at present available in standard square and rectangular solid bits, and in 20 standard styles of welded-tip tools of various sizes, for turning, facing, and boring. In addition, special tools, including solid bits or brazed-tip styles for grooving or forming special contours, are being made to users' specifications.

Further information about "Stellite" 98M2 steel cutting tools can be obtained from Haynes Stellite Company, Kokomo, Indiana.

BJ Casing Pump Anchor

THE increasing use of casing pumps has resulted in the manufacture of a device for safely anchoring such pumps and for prompt release when it is necessary to remove them from the well.

The large-area slips have diagonally-cut teeth, and the hazard of damage to the casing is minimized. The body is welded to the tubing nipple, which is free to move through the anchor cage a sufficient distance to set the slips when the following easy method is used:

Casing pumps usually are run in the well on the sucker rods, with the BJ Casing Pump Anchor coupled to the lower end of the pump. The anchor cage is equipped with friction shoes that contact the casing, and when the desired depth has been reached the rod string is raised until the key on the nipple comes out of the pocket in the anchor cage. Rotation to the right brings this key over its keyway and then by lowering the string the anchor holds the actuator and slips and the body expands the slips and sets them against the casing.

Detailed information regarding sizes and prices is obtainable from Byron Jackson Company, Houston, Los Angeles, or New York.

P & H Designs New Welder Trailer

TO aid in conserving rubber for direct war needs, Harnischfeger Corporation, Milwaukee, Wisconsin, has announced the immediate substitution of an all-steel wheel portable mounting on its P&H gas engine-driven welders for the rubber-tired trailer. The new trailer is of the two-wheel type, equipped with an axle and heavy-duty springs, and suitable for field work and highway towing. The wheels have a 24-in. diameter and 4-in. rim face, and are designed to permit quick changeover to a pressed steel wheel with pneumatic tire when available later. The towing bar and trailer rest have not been changed. To compensate for the harder riding of steel rimmed wheels, the new unit is built for heavy duty in every way, with a 9-leaf spring as well as extra heavy axle.

The welding range of P&H gas engine-driven models is from 15 to 370 amp.

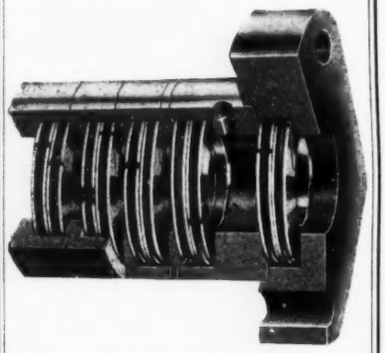
The HIGHER STANDARD

Conserve your equipment and you serve your country. First, buy the best cable tools you can get, because they perform more efficiently and wear better. Then use them carefully, so that they provide full value and efficiency throughout their service-life. You'll be doing your part to save vital materials and man-hours for America's Victory March.

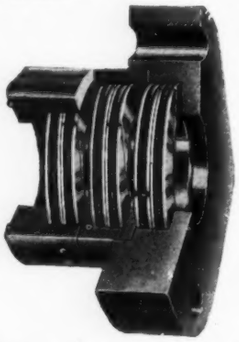
SPANG & COMPANY, BUTLER, PA.

SPANG NAME IN CABLE TOOLS

√ Compressors
√ Engines
√ Pumps
KEEP 'EM HUMMING!



Type No. 270. Designed especially for gas compressors. France Metal "Full-Floating" Packing is outstanding for its long wearing qualities. Eliminates frequent shut-downs.



Type No. 190. Designed for shallow stuffing boxes and prevents condensation from entering the crankcase. Prompt delivery assured.
Specify the packing that L-A-S-T-S —FRANCE "Full-Floating" Metal Packing. *Ask for catalog No. M-3.*

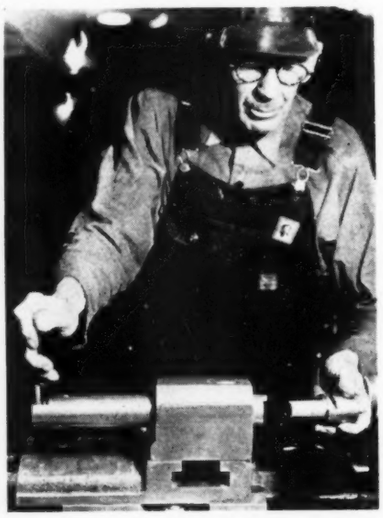
THE FRANCE PACKING COMPANY
Tacony Philadelphia Penna.
Mid-Continent Representative:
MR. J. M. FULLER, 3725 W. 7th St.
FORT WORTH, TEXAS

Original
FRANCE
METAL PACKING

Tool Holder Speeds Lathe Output

A SIMPLE and rugged engine lathe tool holder that is said to reduce tool changing time to approximately five seconds and greatly reduces operating time has been developed by the Lane-Wells Company, engineers and manufacturers, Los Angeles, California.

Known as the Lane-Wells Universal Tool Holder, the device consists of a tool post that can be fitted on any engine lathe carriage compound rest. Into a cylindrical member, clamped into the



tool post, fit the detachable heads. Standard high-speed tool bits used for boring, turning, threading, facing, or forming are fastened into the heads and each bit remains in place in the head. Drills and reamers can also be used.

In practice the lathe operator has several heads each carrying a tool to perform a certain operation on the stock. The first head is placed in the tool holder and locked in place by a quarter-turn of the control handle. As soon as the operation on the stock is performed by the first tool, the operator releases the head, replaces it with the second head, locks it in place, and is ready for the next operation. The change requires approximately five seconds. After sizes are once established all readings can be taken from the cross-feed dials.

If a particular tool must be removed and then reinserted in the tool holder, as for example when a particular working operation is interrupted by other work to be done, the Universal Tool Holder permits the original tool to be reinserted in the tool holder in exactly the same position it originally occupied. Work can then be resumed without the necessity of resetting the position of the tool holder relative to the work. The ordinary engine lathe, equipped with the Universal Tool Holder and a supply of detachable heads, makes possible any number of operations. The one tool holder will perform either outside turning or boring operations.

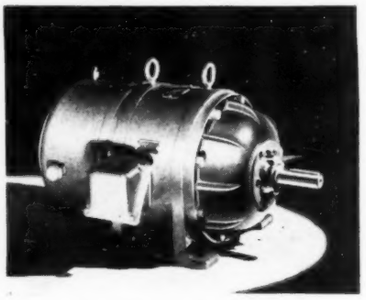
In actual practice during the last year in the Lane-Wells plant, in the manufacture of oil-well supply parts, the Universal Tool Holder made possible a reduction of 35 percent in machining time on many operations, it is stated.

Four sizes of the device fit all standard makes of engine lathes from 10 in. to 24 in.

Complete details and specifications are available from Lane-Wells Company, 5610 South Soto Street, Los Angeles, California.

Motors for Magnesium Dust Locations

A NEW line of polyphase induction motors in sizes from 1 to 20 hp., NEMA frames 203 to 326, inclusive, suitable for use under magnesium dust conditions has been announced by the General Electric Company, Schenectady, New York. Labeled as suitable



for Class II, Group E locations, the new line should find extensive use in the rapidly growing number of plants handling magnesium, particularly where fine magnesium dust is encountered, it is announced.

The design of the new line of motors is based on a series of tests recently initiated by G. E. at the Underwriters' Laboratories, Inc., in which a sample 15-hp., 1800-r.p.m. motor was subjected to a cloud of fine magnesium dust while operating under heating and cooling cycles simulating several years' operation in an industrial plant. Careful examinations of the motor after these tests indicated that it had successfully withstood all tests.

These motors are totally enclosed, with a nonventilated construction in the smaller ratings and a fan-cooled construction above 2 hp. Simple cast-iron end shields, stator frames, and fan housings make it dust-tight without complicating assembly or disassembly.

Other features of the new line include nonsparking bronze external fans, relatively straight and smooth external ventilating passages (for fan-cooled motors) to facilitate cleaning, permanently sealed-in leads, and a rotating labyrinth seal at the shaft opening.

Portable Water Purifier

A SELF-CONTAINED water purification unit that uses no chlorine or other chemicals has been designed by the Technicraft Engineering Company,

5610 South Soto Street, Los Angeles, California. The unit, known as the Sterozone Model B, is light enough to be dropped by parachute in remote areas.

The unit sterilizes water, killing all bacteria, controls taste and odor, and reduces color. Advantages pointed out by the manufacturer are complete water purification without use of chlorine or other chemicals now on the restricted list, automatic operation that does not require supervision by highly trained technicians, and extremely low-cost operation.

Full details and specifications of Sterozone Units are available from the manufacturer.

Non-Indicating Controller

A NEW controller to be known as the Tag Number 42 has been recently placed on the market by C. J. Tagliabue Manufacturing Company, Park and Nostrand Avenues, Brooklyn, New York.

Basically, the movement is the Tag Principle of Control that has served industry so successfully for many years. It has been redesigned for compactness in such a fashion that the few simple parts are accessible with exceptional ease. The small size does not affect the interchangeability of the tube systems, which can be accomplished with surprising facility, it is asserted.

The company has prepared an interesting description giving the complete details of operation, specifications, and prices, included in a new 36-page catalog No. 900E. This book covers the complete line of Tag non-indicating controllers, diaphragm valves, and accessories. A copy of this catalog will be sent on request.

OTIS

TYPE G SIDE DOOR CHOKE

With the ability and precision of a P-40 in combat, the Otis Type G Choke simplifies the completing and producing of two-zone wells.

Entrance of fluid from either or both pays into the tubing string through Removable Bottom Hole ports can be blanked off or regulated as desired by use of the Otis Side Door Choke thereby providing a means to—

1. "Bring in" the Annulus after the well surface connections have been hooked up and tied down.
2. Take Bottom Hole Pressure of each formation independently of the other.
3. "Kickoff" the Annulus should it become loaded up.

All these operations can be accomplished under pressure without moving the tubing or breaking the packer seal.

By equipping the choke with a blank cup mandrel which has an open bore, the upper formation is blanked off, permitting flow into the tubing from the lower pay only. Conversely, if a perforated cup mandrel is used with its lower end plugged, the lower formation is blanked off and the tubing made a conductor for the upper formation only.

The Type G Choke can be run and pulled under pressure with the same line used to run and pull the bottom hole pressure instruments.

Consult your nearest Otis Representative for complete details and information

OTIS PRESSURE CONTROL, INC.
DALLAS, TEXAS

Branches: Houston, Texas; Hobbs, New Mexico; New Iberia, Louisiana
Representatives: Otis Eastern Service, Inc., Wellsville, New York; Western Pressure Control, Los Angeles and Bakersfield, California
Export Office: 74 Trinity Place, New York City

PRESSURE CONTROL OTIS SERVICE - EQUIPMENT

GUIBERSON
SWABS
Produce
WELLS AT CAPACITY
It is highly important that production of present wells be maintained at high levels. Wartime economy requires that this be accomplished at lowest possible cost in materials, time and money through use of the most efficient equipment.
The GUIBERSON Swab has long been recognized as the most efficient on the market, due to its principles of design and construction. It falls faster than any other swab and pulls more fluid per trip and per cup life, resulting in important savings both in swabbing time and replacement costs. For full particulars see the Composite Catalog or write
THE GUIBERSON CORP.
DALLAS, TEXAS
Export Representative: I. Frank Brown, 30 Rockefeller Plaza, New York City
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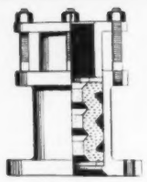

Tubing Stripper

Flow Valve

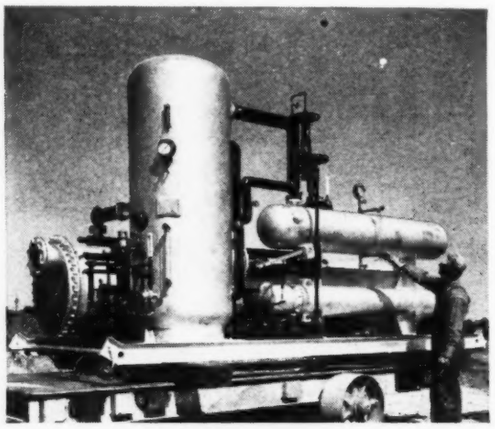
Sucker Rod Stripper

MACHINERY and EQUIPMENT

B S & B Fuel Vaporizer

TO produce fuel for pipe-line engines at a low cost, Black, Sivalls and Bryson, Inc., Oklahoma City, Oklahoma, recently announced that they would manufacture and distribute the BS&B Fuel Vaporizer, which automatically strips enough gas out of the pumped crude oil to run pumping engines.

When natural gas is unavailable, or when fuel economy is desired, the BS&B Fuel Vaporizer enables operators to pump



BS&B FUEL VAPORIZER

with gas engines. According to the manufacturers, pumping fuel costs can be reduced, and the expense of Diesel fuel and its transportation can be eliminated by converting Diesel engines to gas. Also, loss of crude gravity can hardly be noticed, it is asserted.

In operation, the BS&B Fuel Vaporizer takes a small stream of crude oil from the discharge of the pipe-line pump. This oil is routed through a heat exchanger, and then through a tubular exhaust gas heater into a flash tower where a bit of gas is "topped off." This gas is conducted to a storage receiver and drip, then delivered through a regulator to the fuel system of the engine. Exhaust gases provide heat for the generation.

Cold engines can be started with the gasoline that accumulates in the drip. The "topped" crude is cooled back through the heat exchanger and delivered into the pipe line downstream from the pump.

An example given by the manufacturer of the efficiency of the BS&B Fuel Vaporizer can be found in the following example taken from an installation now in operation: The vaporizer generates all the gas required to run two 150-hp. engines pumping 13,500 bbl. of crude oil per day. Five-eighths of 1 percent (83.8 bbl. per day) of the crude is shunted through the vaporizer, which gassifies 10.4 bbl. (12.4 percent) of it for fuel. With crude at 77 cents per bbl. the cost per month for fuel is $240. Former cost per month with purchased gas was $430.

The Fuel Vaporizer is manufactured by BS&B ready for installation and operation, complete with regulators, meters, etc., and is mounted on skids for easy handling. It is built in several standard sizes.

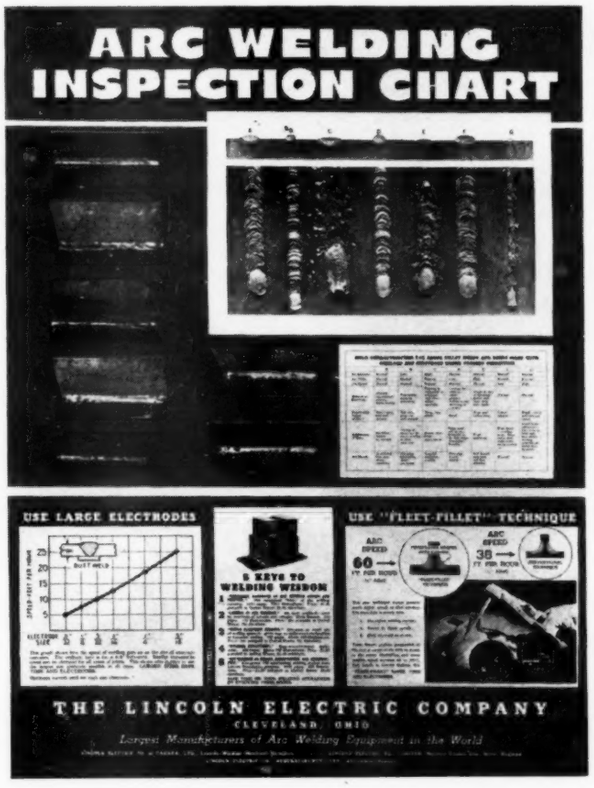
Eyeshield

A NEW eyeshield, easily attached to any of the popular type helmets, is designed to protect the welder's eyes during operations other than welding. It tends to eliminate reflected glare, affords wide vision, protects the eyes from flying scale from chipping hammer or wire brush. Loading of welding holder, set-up work, and other details may be accomplished without raising the visor. It is made by Jackson Products, Detroit, Michigan.

Weld Inspection Chart Published by Lincoln

An arc-welding inspection chart, which will provide welding inspectors and others concerned with weld production a simple and extremely helpful aid for use in inspecting welds, has been published by The Lincoln Electric Company, Cleveland, Ohio.

The chart (see illustration) presents graphically the different types of welds obtained when the work is done normally, with normal current, voltage and speed, as compared with those obtained when these factors are not normal.


ARC WELDING INSPECTION CHART
USE LARGE ELECTRODES
5 KEYS TO WELDING WISDOM
USE "FLEET-FILLET" TECHNIQUE
THE LINCOLN ELECTRIC COMPANY
CLEVELAND, OHIO
Largest Manufacturers of Arc Welding Equipment in the World

"Upon inspection after welding, certain tell-tale signs will reveal considerable information to a qualified inspector," according to A. F. Davis, vice-president of the company.

"Items to consider in inspection after welding include the size and shape of bead, appearance of the bead, undercut, overlap, location of craters (indicating where the operator started and stopped welding). A study of the weld and proper interpretation of tell-tale signs will disclose other conditions of welding." Enlarged photographs illustrate these conditions.

Accompanying the photographs is a table indicating the burn-off of the electrode, the penetration of fusion, the appearance of the bead, and the sound of the arc with each value of current, voltage, and speed of welding. For example, with normal current, voltage and electrode speed, burn-off of the electrode gives a normal appearance of the weld coating, a fairly deep and well-defined penetration, excellent fusion of the bead with no overlap, and an arc that burns with a sputtering hiss plus sharp cracking.

The inspection chart also illustrates the use of the "Fleet-Fillet" technique of welding, developed by The Lincoln Electric Company, which almost doubles the normal welding speed, according to the manufacturer. The chart also illustrates how the speed of welding increases as the size of the electrode increases.

The chart is available free of charge to inspectors of welding and others concerned with welding.

GUIBERSON
CATCHERS
Safeguard
YOUR EQUIPMENT
There is no more urgent requirement in the program of war economy than that of conserving steel. Any safety device that can be placed on or in a well at nominal cost, to protect equipment — and especially pipe, the heavy-tonnage item in production — is today of tremendous importance.
The GUIBERSON Tubing Catcher's function in safeguarding tubing strings from falling, not only due to overloading or faulty threads, but possibly even on account of enemy action — is more important today than ever in the past. Every string of tubing should be equipped with a GUIBERSON Catcher. For details see the Composite Catalog or write
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"DERRICK"
CHROME CLAD
STEEL TAPES

Here's the ideal tape for oilmen who work on a derrick. It's easy to read. Jet black markings show up prominently against a satin chrome surface that won't rust, crack, chip or peel. The narrow (¼") line reduces wind resistance. Order from your supply house. Write for free Catalog today.

Large end ring and hook permit rapid, accurate measuring of casing standing upright in a derrick.

LUFKIN
SAGINAW, MICHIGAN • New York City
TAPES . RULES . PRECISION TOOLS

Los Angeles Nomads Hold Annual Party

Approximately 200 Nomads and their guests enjoyed the annual "Wing-Ding" of the Los Angeles Chapter of Nomads held at the Cheviot Hills Country Club, Los Angeles, during the entire day and evening of July 24. Beginning with a golf tournament in the morning and afternoon, games of skill were then played until dinner was served shortly after eight o'clock. After the dinner, golf, gaming, and door prizes were awarded. The tables were then removed and chairs arranged around the hall to supply good seats for everyone to see the show that climaxed the entertainment.

A silver cup was awarded for the low gross golf score and was captured by A. K. Smith of Western Gulf Oil Company. Six blind bogey prizes were to be given but two will have to be awarded later because of a tie. Those receiving their prizes were Fred Currie of Timkin Steel and Tube Division, Jim Creed of Halliburton Oil Well Cementing Company, Ralph Porter of Standard Oil Company of California, and F. A. Driskill of the Iraq Petroleum Company. Herb White of Republic Supply Company, Paul Huggins of Western Gulf Oil Company, and George Trembley of Howard Supply Company will play off the tie for the two other prizes.

All prizes except those for golf were war bonds and stamps. Those winning bonds for their "skill" in the games played before dinner were Paul Cavins, a $50.00 bond; Jud Saatjian of The Texas Company a $25.00 bond, and Bob Eiche a $25.00 bond. The first door prize of a $25.00 bond went to Bill McGuirk of Eason-Therolf Tool Company. Ted Sutter of Baker Oil Tools, Inc., won $10.00 in stamps as did Ray Love of Tide Water-Associated Oil Company. The winners of another $25.00 bond and three more $10.00 stamp prizes failed to give their names so their identity remains unknown.

Credit for the great success of the Nomads "Wing-Ding" goes to the committee, which consisted of Roland Smith of Grant Oil Tools, chairman; Tom Murphy of Martin-Decker Corporation, who got into the army before the party and could not enjoy the fruits of his labors; Jim Robinson of Miller-Robinson; George Trembley of Howard Supply Company, and Bob Eiche, foreign tool representative. George Trembley and Bob Eiche were in charge of the golf tournament.

The next meeting of the Los Angeles Chapter of Nomads will be a barbecue to be held the middle of September. Details are now being arranged.

Cummins Engine Company Appoints New Service Manager

Recognizing the importance of Service Department training and experience, the Government has again called upon the Cummins Engine Company for men with experience in this field. Dave Cravens, Cummins' service manager, was the first to volunteer his services. Robert Bloomenstock, also of the service and parts department, was next, being appointed to special Diesel work in the

DELOSS CUMMINS

Navy. Now, Robert Stratton, former Cleveland regional manager who replaced Cravens as acting factory service manager, has accepted a commission in the U. S. Signal Corps. Upon Stratton's departure to assume his new Army duties, P. E. Letsinger, vice-president in charge of distribution, has announced the appointment of Deloss Cummins as service manager.

Affiliated with the Cummins company almost since its inception, Cummins first worked on the assembly line in 1915, eventually became factory superintendent in 1924 and filled that position until his transfer to the service department in 1929.

Cummins has worked in the field with dealers, distributors, and owners and this fact, in conjunction with his background of factory experience, gives him a full understanding of service problems from every angle. He states that no radical changes in the present service policy are anticipated. "We realize that many Diesel mechanics have been called to the various branches of the service," says Cummins, "and by an increased number of Service Bulletins and other literature, are going to try to establish a program of information that will be helpful to mechanics that are new to the Diesel field. We also pledge our closest coöperation with the Government in their various training programs throughout the country."

Parkersburg and O. C. S. Consolidate

Casper A. Ruf, president and general manager of The Parkersburg Rig and Reel Company, announces that on July 31, The O. C. S. Manufacturing Company terminated its corporate existence, and is now operating as a division of The Parkersburg Rig and Reel Company.

D. C. Myers, formerly vice-president and general manager of O. C. S., has been elected a vice-president of The Parkersburg Rig and Reel Company with headquarters at Coffeyville, Kansas.

William Schwemlein has been named manager of the Coffeyville Works, O. C. S. Division.

New Deal Takes Over Butler Manufacturing Equipment Line

New Deal Specialty Company, Okmulgee, Oklahoma, announces the acquisition of products of the Charles A. Butler Manufacturing Company, also of Okmulgee, which has for many years manufactured a line of oil-field equipment widely used in the oil industry. The New Deal Specialty Company will continue sale and service of the Butler products.

The Butler products include their line of slip ring casing elevators, automatic casing spiders, safety tubing elevators and spiders, compound lever wire line drilling clamps, roller bearing beam pulleys, and pipe tongs.

The New Deal Specialty Company announces they have also acquired the real estate and plant buildings of the Butler company, all of which will be maintained for future manufacturing operations. Thus, company officials believe, they will be better equipped for the service of the Butler products as well as the "New Deal" equipment, which includes pipe-cleaning machines and pipe-straightening machines, tripods, etc.

South American Outlets for Wheelco

Announcement of three new South American sales outlets for products of Wheelco Instruments Company, Chicago, Illinois, has been made by Richard A. Schoenfeld, vice-president and sales manager. Cia Argentina de Ingeneiria Industrial, with headquarters at 375 Peru, Buenos Aires, will represent the company in Argentina; Miguel Khalife, with A. P. Green Chilena Ltda., at Casilla 13297, Santiago, in Chile, and Benech & Cia, at Cerrito 455, Montivideo, in Uruguay.

W.P.R.A. Planning Two Regional Technical Meetings for Fall

Plans are taking definite shape for two regional technical meetings of the Western Petroleum Refiners Association this fall, according to announcement of J. C. Day, secretary of the association. First of the meetings will be held in Wichita, Kansas, at the Allis Hotel, on Friday, October 9, followed by one in Shreveport, Louisiana, at the Washington-Youree Hotel, on Friday, October 30.

In arranging programs for the regional meetings this year, officials of the association indicate they expect to follow the same procedure as in previous years, with three highly important and timely technical papers to be presented at each meeting.

Although the programs are not yet complete, the discussions will likely center around the effects of the war emergency on the refining industry. There have been many new developments and changes, and these will be discussed so far as consistent and practicable. An open forum, always popular at these technical group meetings, will follow each paper.

Details of the programs, with titles of papers and names of authors, will be given at a later date.

In This—The Great Emergency—

CLEVELANDS

As Always—Are Coming Through!

When there is ditch to dig....or fill....
You'll always be glad you bought a

"CLEVELAND"

Keep them in fighting trim by regular attention to maintenance and lubrication.

Herrington Made Director Society of American Military Engineers

A. W. Herrington, president of the Society of Automotive Engineers, technical advisor to Col. Louis A. Johnson on the recent American Economic Mission to India, and president of The Marmon-Herrington Company, of Indianapolis, Indiana, has been elected to serve for three years as a director of the American Society of Military Engineers.

Herrington is widely known throughout the world as an expert on military transport, and is the designer of many military vehicles now in the service of the United Nations on all the major battle fronts of Europe and Asia. His company at Indianapolis was one of the first automotive companies in the United States to achieve full-scale conversion to war production, and Marmon-Herrington vehicles were among the first of American manufacture to go into action in both the Near and Far East.

As a captain in the military transport service of the A. E. F. during the first world war, and later during many business trips to the old world, Herrington had opportunity to study the terrain and transportation problems of most of the countries now in the war. His observations and knowledge of automotive engineering suggested numerous improvements in design of the All-Wheel-Drive trucks, track-lying tractors, and tanks, which are used extensively by the United Nations.

In peace time Marmon-Herrington All-Wheel-Drive converted Ford trucks and heavy-duty All-Wheel-Drive vehicles have helped develop many of the major oil fields throughout the world. The entire output of the greatly enlarged Marmon-Herrington plant is now given over, however, to the building of vehicles of war.

Foxboro Company Awarded War Bond Honor Flag

The Foxboro Company, Foxboro, Massachusetts, makers of measuring and controlling instruments for industrial processes, was awarded the Minute Man flag of the Treasury Department recently in recognition of payroll allotment subscriptions by more than 95 percent of its employees. The coveted flag and accompanying certificate were presented by Alfred C. Sheehy, Deputy State Administrator of the War Savings Staff for Massachusetts, and received by Irving W. Lane, second oldest employee of the company. Arrangements were in charge of Corodon S. Fuller, an official of the company and chairman of the War Savings Committee for Foxboro. He was assisted by Alfred Herschel of the company's personnel department. The presentation followed a noon-hour concert by The Foxboro Company Brass Band.

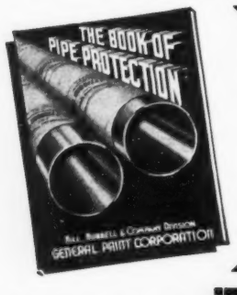
Engine and Boiler Standards, Boiler Code, Revised by A.P.I.

Revisions in the standard specifications of internal-combustion engines for oil-field service and for oil-field boilers, and in the code of recommended field practice on care and use of oil-field boilers have been published by the American Petroleum Institute's Division of Production. The revisions incorporate changes adopted at the Institute's annual meeting at San Francisco in November, 1941.

Copies of the new additions (A.P.I. Std. 11-C, Fifth Edition, A.P.I. Specification for Internal Combustion Engines for Oil Field Service; A.P.I. Std. 2, Ninth Edition, A.P.I. Specifications for Oil Field Boilers, and A.P.I. Code 2, Second Edition, A.P.I. Code of Recommended Field Practice on Care and Use of Oil Field Boilers) may be obtained from the Institute at 50 West 50th Street, New York, or Continental Building, Dallas, Texas, for 50 cents each.

HILL—HUBBELL

MACHINE PROCESSED STEEL PIPE is PROPER PROTECTION••



Write today for your copy of "THE BOOK OF PIPE PROTECTION," which describes our process in detail.

Hill-Hubbell Coated-and-Wrapped steel pipe is produced at these leading mills:

- Jones and Laughlin Steel Corp.
- National Tube Company
- Spang Chalfant, Inc.

Even now as we fight the Axis, and later, too, when peace does come, we shall still have to fight the Battle of Corrosion—that silent, unseen enemy that sneaks up from behind.

★

GENERAL PAINT CORPORATION
HILL, HUBBELL & CO. • Division • Cleveland, Ohio
• EXPORT OFFICE SAN FRANCISCO, CALIFORNIA, U. S. A. •

M. E. Nicklin Now Has Office at Oil City

M. E. Nicklin, manager of the Export Division, Oil Well Supply Company, 30 Rockefeller Plaza, New York City, now has his office at the manufacturing headquarters of the company at Oil City, Pennsylvania. The change was effective August 1.

Nicklin continues as manager of the Export Division dividing his time between the New York and Oil City offices, thus bringing about a closer liaison between production and the export trade.

R. H. McPeake, sales manager of the Oil Well Supply Company, Export Division, will continue to make his headquarters in New York City and will be in charge of the New York office when Nicklin is out of the city.

Chicago Section A.C.S. Moves Headquarters

The Chicago Section of the American Chemical Society has moved its headquarters to the Medinah Club, 505 North Michigan Avenue, Chicago, Illinois, as of August 1.

This move was made necessary by the fact that the United States Army requisitioned the Stevens Hotel for the lodging and training of army and air force technicians. The Stevens has been the headquarters of the section for many years.

The Chicago Chemists Club, which shared the quarters of the Chicago Section in the Stevens Hotel, has made a similar arrangement with the Chicago Section for the use of quarters at the new address.

The Medinah Club offers commodious and convenient rooms for dinners and large gatherings, as well as adequate rooms for group meetings and the like.

Lincoln Electric Gives Service Pins to Veteran Employees

The Lincoln Electric Company, Cleveland, Ohio, has awarded service pins to 206 veteran employees whose tenure of service ranges from 10 to 35 years.

Two recipients of citations whose service records extend over a period of 35 years were James F. Lincoln, president and general manager, and J. C. Lincoln, chairman of the board and treasurer. Service pins were presented to J. F. Lincoln by A. F. Davis, vice-president and secretary of the company, and to J. C. Lincoln by J. F. Lincoln. Employees presented the company president with a watch and chain and a scroll that read:

"To James F. Lincoln

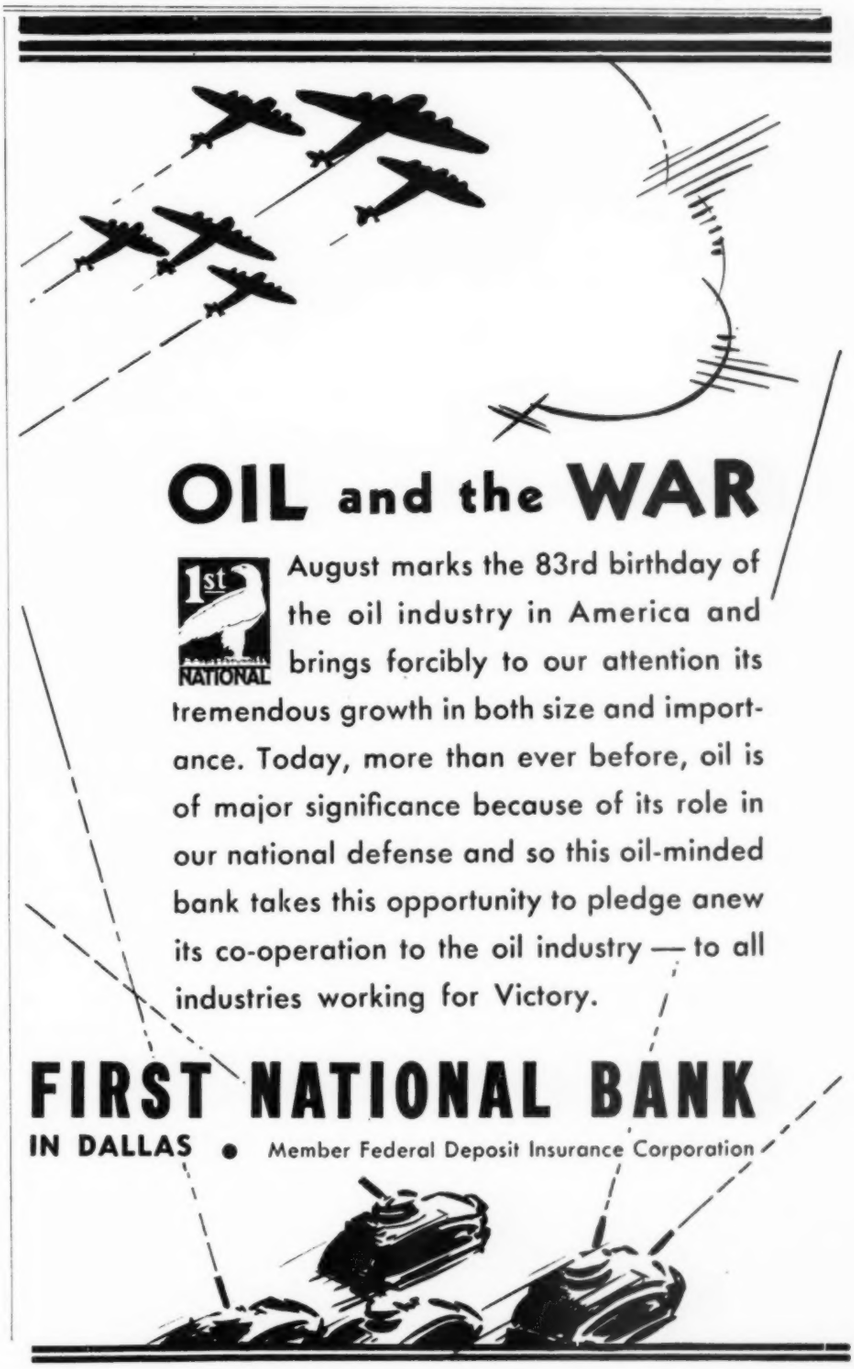
"We reaffirm our confidence in your foresighted leadership, again express our appreciation for your friendly understanding of our problems, and pledge our continued effort and enthusiasm for the biggest job we have ever had—winning the war by more production.

Your Fellow Workers."

A service pin was given to Joe Satava, Jr., inspector in the punch press department, who has worked for The Lincoln Electric Company during the last 30 years. This pin was presented by Davis. The other presentations were made by directors of the company, which included: J. F. Lincoln; A. F. Davis; C. M. Taylor, vice-president and sales manager; G. G. Landis, chief engineer, and H. F. Kneen, factory manager.

Service pins were given to eight 25-year employees, among whom were Davis and Taylor. The others in this group were: Mary Friedel, of the winding department; R. A. Gast, mechanical engineer; A. J. Goetz, production department; Earl Reed, shipping department; C. W. Roehl, purchasing agent, and Frank Blazek, inspector.

There were 26 employees in the 20-year group; 66 in the 15-year group, and 103 in the 10-year group.


OIL and the WAR
1st NATIONAL
August marks the 83rd birthday of the oil industry in America and brings forcibly to our attention its tremendous growth in both size and importance. Today, more than ever before, oil is of major significance because of its role in our national defense and so this oil-minded bank takes this opportunity to pledge anew its co-operation to the oil industry — to all industries working for Victory.
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R. F. Runge Passes Away

Robert F. Runge, vice-president of S K F Industries, Inc., Philadelphia, Pennsylvania, died recently after a prolonged illness. He was 56. Runge was born in Woodbury, New Jersey, and was graduated from Drexel Institute in 1906. He went to work in the engineering department of the Hess-Bright Manufacturing Company, which later became S K F.

His entire business career was spent with S K F and its predecessor, the Hess-Bright firm. He became vice-president in 1920.

Production Allocation Report Published by A.P.I. Committee

Fundamental principles of oil production and recommended factors in the application of these principles to sound proration practices are published in a progress report of the American Petroleum Institute's Special Study Committee on Well Spacing and Allocation of Production and its Legal Advisory Committee. The report has been issued in a 98-page book.

The committee reached nine conclusions from its studies, covering the necessity for conservation, the causes of waste, and the principles of regulation and allocation that should be adopted to prevent waste. Appendices give extensive bibliographies of legal and engineering phases of proration and production, and a report of the Engineering Committee of the Interstate Oil Compact Commission. Copies of the book may be obtained from the Institute at 50 West 50th Street, New York, New York, and Continental Building, Dallas, Texas; price is $1.25.

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Distributors: Kansas, Pampa and Borger, Texas, Illinois, Bovaird Supply Co.; Texas and Louisiana, Mid-Continent Supply Co.; Oklahoma City, Production Supply Co.

New Date for National Chemical Exposition

Announcement is made by the Chicago Section of the American Chemical Society of a change in dates and location for its second National Chemical Exposition, owing to the acquisition of the Stevens Hotel in Chicago by the United States Army.

The exposition and conference have been transferred to the Sherman Hotel, conveniently situated in Chicago's business center at Clark and Randolph Streets, and will take place from November 24 to 29 instead of a week earlier as originally planned.

"Adequate space will be available for a show about twice as large as the first exposition sponsored by the Chicago Section in 1940 and under most advantageous conditions," said Victor Conquest, chairman of the show committee.

"Our preliminary survey indicates that we can accommodate more than 100 exhibitors. Just how many in excess of that number we can take care of is a question at this time. Our original plan provided spaces for 145 exhibitors. It is important, therefore, that all who plan to exhibit in this important war-time show file application for space at once."

No changes are planned in the original program for the big show, it is announced. There will be daily conferences to be addressed by leaders in the chemical industry, educators, and other outstanding authorities. The committee is arranging for an interesting display of motion pictures. Adequate accommodations will be available in the Sherman Hotel for the thousands of visitors expected from all over the country.

Conquest points out that the importance of the show cannot be overestimated. The chemical industry is vital in the war effort. Many new processes and discoveries will be revealed. The exposition will offer the opportunity to exchange ideas and to view latest developments in an industry that has contracts for construction projects totaling $72,118,000 this year as compared with $46,996,000 a year ago.

Procedure for Obtaining Higher Priority Rating

New procedure for obtaining higher priority ratings for materials required to complete projects already under way is explained by Deputy Petroleum Co-ordinator for War Ralph K. Davies.

Previously, when a contractor could not complete his construction work because certain materials had not been delivered, and delivery was being held up because the original priority rating no longer was high enough, the contractor applied for a higher rating on Form PD-1A.

Now, application for higher priority rating need not be made on Form PD-1A. Correct procedure is to write a letter in quadruplicate in which is listed all material items requiring a change in preference rating status. Thus, requests for changes in ratings can now be made in one application, whereas previously a separate PD-1A form had to be made out for each class of items.

In compiling the list of materials in the single application, under the new procedure, however, applicants are requested to itemize the material in accordance with the PD-200A materials list.

The letter should also include information showing builder's serial number, item number, unit of measurement, quantity, price, use of item, latest delivery date permissible, and preference rating required by the supplier to meet the delivery date.

Functions of Foreign Division OPC Defined

Functions of the Foreign Division of the Office of Petroleum Co-ordinator for War have been defined in detail by Deputy Petroleum Co-ordinator Ralph K. Davies in a memorandum addressed to division directors of OPC.

The statement follows:

"It will be the responsibility of the Foreign Division of the Office of Petroleum Co-ordinator for War to co-ordinate action on the many complicated and overlapping phases of foreign petroleum problems in a manner that will assure the availability of the required kinds of products and operating material at the right time and in the right places outside the United States, in quantities which so far as possible will meet war demands and the foreign petroleum industry's necessities.

"To accomplish this purpose the Foreign Division will continue to be the liaison in all matters of foreign petroleum policy and operation between this office and the various other governmental departments and agencies. The latter include the Department of State, the Board of Economic Warfare, the War Department, the Navy Department, the War Shipping Administration, Office of Co-ordinator of Information, the British Supply Council, American British Joint Survey Committee, the Netherlands Petroleum Mission, the China Defense Supplies, Inc., the Office of Lend-Lease Administration, the Soviet Government Purchasing Commission, South and Central American agencies, the Allied Armed Forces, and other similar foreign or domestic bodies handling foreign matters. The Foreign Division will, however, have no responsibility for the allocation of 100-octane gasoline, which problem is now handled by a subcommittee of the Munitions Assignments Board.

"The Foreign Division will be the channel through which all communications will be had with the Foreign Operations Committee and its various subcommittees. Furthermore, the Foreign Division shall be the liaison for the Foreign Operations Committee with all divisions of the OPC and other government agencies and departments.

"For the sake of good order, all communications with these agencies and with foreign operating oil companies should either be made through the Foreign Division or be surnamed by a representative of that division.

"The Foreign Division will continue to obtain from and give to the petroleum industry operating outside the continental United States such information and advice as, from time to time, may be necessary to better augment the flow of petroleum to war effort and assure adequate production, refining, transportation and supply of products in foreign territories.

"It will be the duty of the Foreign Division to furnish to properly designated officials of the Army and the Navy of the United States all information in the possession of the Division which may be needed and properly requested by the armed forces; it shall continue to be the duty of the Foreign Division to act as the channel through which requests for technical advice and assistance on petroleum matters are received from and forwarded to the various agencies and governmental bodies concerned with petroleum products outside of the United States, and specifically those units mentioned above.

"The Foreign Division will continue to collaborate with various other agencies in the preparation of such material as enemy oil reports, demolition and rehabilitation of foreign facilities, geological and engineering surveys of foreign production areas and potential areas, the construction and maintenance of foreign pipe lines, refineries and proposed projects for development of foreign petroleum economy.

"Within the Office of Petroleum Co-ordinator, the Foreign Division shall:

"(1) Collaborate with and make use of the expert technical advice and services of such divisions as may be necessary to carry out the responsibility with which it has been charged.

"(2) Upon request, give to the other divisions of the Office of Petroleum Co-ordinator information and advice upon all matters wherein questions relating to production, refining, transportation, supply and utilization of petroleum products outside the continental United States are involved.

"(3) Determine the allocation, distribution, and diversion of materials for foreign oil operations so as to meet the requirements of foreign policy. The Materials Division will consult with the Foreign Division on questions of quantities of such materials, technical requirements, possible substitutions, and similar problems which the Materials Division is currently handling with the War Production Board.

"(4) Be responsible in the Office of Petroleum Co-ordinator for foreign supply and distribution. In this work it will serve the Petroleum Supply and Distribution Board that has recently been organized as the inter-departmental agency responsible.

"(5) Aid the Division of Research in the securing of such statistical information as is necessary to maintain its records, and collaborate closely with it to see that, without duplication of effort, foreign statistical information is readily available to those who may properly require it."

Some Petroleum Industry Jobs Listed as Essential

The War Manpower Commission has provided for the Director of Selective Service a list of essential activities (Memorandum I-405) by broad industrial groups. The purpose of this list is to assist all agencies of the Government that are concerned with the allocation of the manpower of the nation. This list may be used as a guide by the Selective Service System in determining those activities necessary to war production and those activities essential to the support of the war effort, and thus to assist in determination of the classification of registrants in Classes II-A and II-B and in Classes III-A and III-B.

The following is quoted from Memorandum I-405, List of Essential Activities:

Production of chemicals and allied products: Glycerin, turpentine, resin, and other naval stores; wood tars, oils, acids, and alcohols; lubricating oils and greases; animal and vegetable oils; fertilizers; tanning materials; salt; synthetic rubber; primary coal-tar products; plastics; compressed and liquefied gases; refined sulphur; sulphuric and other acids; caustic and other sodas; industrial alcohols; electrochemical and electrometallurgical products such as carbide, sodium and potassium metals and high-percentage ferroalloys; drugs and medicines; insecticides and related chemical compounds; nylon and other synthetic textile fibers used in military equipment exclusively; grease and tallow; candles. (Explosives, flares, and other fireworks, generally classified as chemical products are included with ammunition.)

Production of petroleum, natural gas, and petroleum and coal products: Drilling, rig building, and maintenance service operations, and petroleum refining. Includes also production of tar and pitch; coal gas, coke.

The following (Section X of Occupational Classification Memorandum to all State Directors (I-405) dated July 15 is quoted in full:

"1. Attached to this memorandum is a list of essential activities which has been provided for the Director of Selective Service by the War Manpower Commission. This list includes under broad activity classifications the products, facilities, and services considered necessary to war production and essential to the support of the war effort.

"2. The attached list may be used by the Selective Service System as a guide for the determination of a registrant's occupational classification. The attached list is also in the hands of other Governmental agencies concerned with activities necessary to war production and essential to the support of the war effort, and will serve as a guide to those Governmental agencies in their functions with respect to occupational questions affecting manpower of the Nation.

"3. When considering a question of occupational classification, the attached list of products, facilities, and services may be referred to in order to determine whether the business in which the registrant is engaged is necessary to war production or essential to the support of the war effort. Since this list comprises broad groups of industrial activities by general type, upon finding that the business comes under one of the groups listed, it should then be determined that it is a civilian activity necessary to war production or essential to the war effort by its meeting one or more of the following tests:

"(a) That the business is fulfilling a contract of the Army, Navy, Maritime Commission, or other Governmental agencies engaged directly in war production;

"(b) that the business is performing a Governmental service directly concerned with promoting or facilitating war production;

"(c) that the business is performing a service, Governmental or private, directly concerned with providing food, clothing, shelter, health, safety, or other requisites of the civilian daily life in support of the war effort;

"(d) that the business is supplying material under subcontracts for contracts included in (a), (b), or (c) above; or,

"(e) that the business is producing raw materials, manufacturing materials, supplies, or equipment, or performing services necessary for the fulfillment of contracts included in (a), (b), (c), or (d) above.

"4. Having found that the business in which the registrant is engaged comes under some group on the attached list, and having applied the tests and made the determination that it is an essential activity under either Part III or Part IV of this memorandum, consideration will be given to the occupation of the registrant within that activity. In the consideration of occupational classification, the tests of the 'necessary man' as provided in Part VI of this memorandum will be applied."

Procedure for M-68 Exceptions

Correct procedure for members of the natural gas and natural gasoline industries who file applications for exceptions under Conservation Order M-68 has been explained by Deputy Petroleum Co-ordinator Ralph K. Davies.

Copies of applications for exceptions are to be forwarded to the Director of Natural Gas and Natural Gasoline, Office of Petroleum Co-ordinator, New Interior Building, Washington, D. C.

The division will handle applications for exceptions concerning the use of materials in natural gas wells; condensate or distillate wells; and natural gasoline cycling, pressure maintenance, or repressuring plants.

Applications for exceptions in other production branches of the industry will continue to be forwarded to the Director of Production, Office of Petroleum Co-ordinator, New Interior Building, Washington, D. C.

In all cases, three copies of the applications should be sent directly to the division concerned in Washington. A fourth copy should be mailed or delivered to the OPC district director of natural gas and natural gasoline or the district director of production, as the case may be, for the district in which the lease, pool, or plant is situated.

Davies explained that the applications for exceptions in the natural gas or natural gasoline branch will be expedited if industry operators will address their copies correctly.

The procedure applies to all three application forms for exceptions under M-68: Form 214-a is used by operators applying for an exception for an entire pool or drilling program; Form 214-b for an exception for an individual lease, property, or well, and Form 214-c for an exception for a cycling plant or a repressuring plant.

District offices and the States they cover are:

District 1: 1104 Chanin Building, 122 East 42nd Street, New York City, for Maine, New Hampshire, Vermont, Massachusetts, Rhode

Island, Connecticut, New York, New Jersey, Delaware, Pennsylvania, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, and the District of Columbia.

District 2: Suite 1336, 120 South LaSalle Street, Chicago, Illinois, for Ohio, Kentucky, Tennessee, Indiana, Michigan, Illinois, Wisconsin, Minnesota, Iowa, Missouri, Oklahoma, Kansas, Nebraska, South Dakota, and North Dakota.

District 3: 245 Mellie Esperson Building, Houston, Texas, for Alabama, Mississippi, Louisiana, Arkansas, Texas, and New Mexico.

District 4: 320 First National Bank Building, Denver, Colorado, for Montana, Wyoming, Colorado, Utah, and Idaho.

District 5: 855 Subway Terminal Building, Los Angeles, California, for Arizona, California, Nevada, Oregon, and Washington, and the Territories of Alaska and Hawaii.

Wyoming Crude Ceilings Changed

The maximum price for crude petroleum produced in the Derby and Dallas pools and the Hudson Oil Company's production from the Hudson pool near Lander, Wyoming, has been established at 60 cents per bbl., delivered at Lander, Wyoming, the Office of Price Administration announced July 28.

This new price is fixed in Amendment 24 to Revised Price Schedule 88, as follows:

A statement of the considerations involved in the issuance of this amendment has been issued simultaneously herewith and has been filed with the Division of the Federal Register.

A new subdivision (viii) is added to Section 1340.159 (c) (1) as set forth below:

Section 1340.159 Appendix A: Maximum prices for petroleum and petroleum products.

(c) Specific prices.

(1) Crude petroleum.

(viii) Wyoming. The maximum price for crude petroleum produced in the Derby and Dallas pools and the Hudson Oil Company's production from the Hudson pool near Lander, Wyoming, shall be 60 cents per bbl. delivered at Lander, Wyoming.

Section 1340.158a Effective dates of amendments.

(x) Amendment No. 24 [Sections 1340.159 (c) (1) (viii)] to Revised Price Schedule No. 88 shall become effective July 31, 1942.

(Pub. Law 421, 77th Cong.)

Issued this 28th day of July, 1942.

LEON HENDERSON,
Administrator.

COLMONOY SAVES VITAL METALS

The Pug Knives shown above tell a graphic story of the unusual wear resisting qualities of COLMONOY hard-surfacing alloys and overlay metals.

1. New, 24-pound pug knife, made of high alloy steel.
2 and 3. Same type, after only 3 months of service. Worn beyond efficient operation, with over half of blade material worn away.
4 and 5. Same type. Each blade coated with 1½ pounds of COLMONOY No. 6. In constant use for over a year, and still in efficient operation.

COLMONOY alloys are playing an important part in oil production and refining operations in the United States Pump sleeves, plungers, rings, wash pipes and many other kinds of equipment used in the oil industry are particularly subject to excessive corrosion and abrasion.
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OPA Appoints Oil Committees

OPA has appointed two committees under Section 2 (e) of the Emergency Price Control Act. Additional committees will be appointed later.

This section provides for the appointment of industry advisory committees by OPA.

The pertinent part of this section follows:

Before issuing any regulation or order under the foregoing provisions of this subsection, the Administrator shall, so far as practicable, advise and consult with representative members of the industry which will be affected by such regulation or order. In the case of any commodity for which a maximum price has been established, the Administrator shall, at the request of any substantial portion of the industry subject to such maximum price, regulation, or order of the Administrator, appoint an industry advisory committee, or committees, either national or regional or both, consisting of such number of representatives of the industry as may be necessary in order to constitute a committee truly representative of the industry, or of the industry in such region, as the case may be. The committee shall select a chairman from among its members, and shall meet at the call of the chairman. The Administrator shall from time to time, at the request of the committee, advise and consult the committee with respect to the regulation or order, and with respect to the form thereof, and classifications, differentiations, and adjustments therein. The committee may make such recommendations to the Administrator as it deems advisable. Whenever in the judgment of the Administrator such action is necessary or proper in order to effectuate the purposes of this Act, he may, without regard to the foregoing provisions of this subsection, issue temporary regulations or orders establishing as a maximum price or maximum prices the price or prices prevailing with respect to any commodity or commodities within five days prior to the date of issuance of such temporary regulations or orders; but any such temporary regulation or order shall be effective for not more than sixty days, and may be replaced by a regulation or order issued under the foregoing provisions of this subsection.

The committees already appointed deal with export prices and crude oil prices in District 5. Their membership follows:

Oil Export Committee: D. L. Harper, Standard Oil Company, New Jersey, 30 Rockefeller Plaza, New York City; Laurence B. Levi, director, Socony-Vacuum Oil Company, Inc., 26 Broadway, New York City; W. D. Anderson, Atlantic Refining Company, 260 South Broad Street, Philadelphia, Pennsylvania; C. E. Olmstead, vice-president, The Texas Company, 135 East 42nd Street, New York City; J. E. Black, manager, Foreign Trade Department, Standard Oil Company (California), Standard Oil Building, San Francisco, California; C. S. Jones, president, Richfield Oil Corporation, 555 South Flower Street, San Francisco; D. W. Hovey, president, Gulf Coast Refiners Association, 1613 Second National Bank Building, Houston, Texas; G. L. Rowsey, president, Taylor Refining Company, First Taylor National Bank Building, Taylor, Texas; J. P. Birkin, Asiatic Petroleum Corporation, 50 West 50th Street, New York City; Jack Riddell, Jr., 30 Rockefeller Plaza, New York City; Arthur C. Stewart, Union Oil Company of California, Union Oil Building, Los Angeles, California, and Will J. Reid, Hancock Oil Company, 2828 Juniper Avenue, Los Angeles.

District 5 Crude Committee: Ernie E. Pyles, 1160 Subway Terminal Building, Los Angeles, California; L. L. Aubert, president, Bankline Oil Company, 437 South Hill Street, Los Angeles; F. S. Bryant, director, Standard Oil Company of California, Standard Building, San Francisco; E. F. Davis, vice-president, Shell Oil Company, Inc., Shell Building, Shell Corner, San Francisco; W. M. Keck, Jr., vice-president, Superior Oil Company, Edison Building, Los Angeles; A. D. Mitchell (Independent Operator), 2941 Cherry Avenue, Long Beach, California; L. P. St. Clair, Oil Administrator, California Conservation Committee, Los Angeles; Lawrence Vanderleck, vice-president, Fullerton Oil Company, 1020 Security Building, Los Angeles; W. C. Whaley, Barnsdall Oil Company, Petroleum Securities Building, Los Angeles; Lloyd Williamson, California Star Oil Company, 510 South Spring Street, Los Angeles; William F. Humphrey, president, Tide Water Associated Oil Company, 79 New Montgomery Street, San Francisco; Richard Fenton, vice-president and secretary, California Stripper Well Association, Los Angeles, and R. E. Collom, vice-president, Continental Oil Company, Los Angeles.

Smackover Operators May Plug-back Wells

Exception to federal well-spacing regulations, which will enable operators in the Smackover field of southern Arkansas to plug-back wells to shallower producing zones, has been granted by the Director General for Operations, WPB, on recommendation of the Office of Petroleum Coordinator for War.

Under the field-wide program of action now possible, the producing lives of many wells will be prolonged and the ultimate recovery of oil from the field substantially increased.

The authorization eliminates the necessity for each operator to apply individually for an exception to Conservation Order M-68 to permit the use of materials required for recompletion operations. As more than 3700 wells had been completed in the Smackover field by the end of 1941, this procedure would have involved considerable delay and expense, as well as some loss of production.

The application for a field-wide exception to M-68 was initiated by the Arkansas Oil and Gas Commission. It is the first case on record in which a state agency has held a field-wide hearing, assembled evidence, and then prepared an application for exception in behalf of all the operators in a field. The Office of Petroleum Co-ordinator strongly favors such procedure wherever practicable.

Need for a plugging program in the Smackover field arises from the fact that many of the wells producing from the lower zones are making so much water that they are no longer economical to operate.

The order will permit all operators in the field to plug-back to higher producing zones at will and recomplete wells so that the recoverable oil remaining in such zones can be produced from existing wells.

About the only critical materials required for the operation are cement and perforating bullets. Cement is used to plug a well back to a shallower producing zone, the bullets to pierce the casing at the new level at which production is being sought.

☆ ☆ ☆

D. C. Roberts Promoted by Sperry-Sun

Dwight C. Roberts, regional manager at Houston, Texas, for Sperry-Sun Well Surveying Company, has been promoted

DWIGHT C. ROBERTS

to assistant general manager of the company. He assumed his new duties August 1 and will continue to make his headquarters in Houston.

Air Corps Wants Second-hand Storage Tanks

The Army Air Corps needs second-hand tanks suitable for use in bulk storage of aviation gasoline and lubricating oil, according to a request for a list of such tanks by the Engineer Corps at San Francisco, California, forwarded to Oil Producers Agency of California.

The letter, signed by Lt. Col. A. H. Griffin, says: "This office would appreciate receiving a list of suitable second-hand tanks available for purchase by the Government for use in storing aviation gasoline and lubricating oil at Air Corps Stations."

The district office of the United States Engineer Corps is at 74 New Montgomery Street, San Francisco.

Letters to the Editor

Shreveport, Louisiana,
July 22, 1942.

Gentlemen:

What! No Laugh With Barney? We really miss that page. I mail it to friends in the Armed Forces for local color. I feel sure it is greatly missed by them; also by many others, including

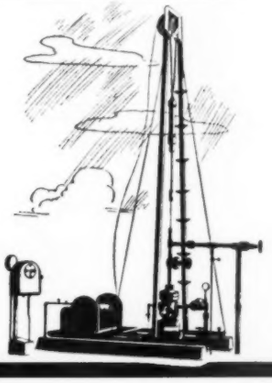
Yours truly,
R. L. LONG.

"Barney" was omitted from the Annual Number (July 1) of *The Petroleum Engineer*. This is the one number from which all regular features are omitted. "Barney" is not being dropped.

N.P.A. to Hold Meeting in Pittsburgh

By reason of the fact that all suitable hotels at Atlantic City have been taken over by the Army Air Corps, it has been decided to hold the 40th annual meeting of the National Petroleum Association at the William Penn Hotel, Pittsburgh, Pennsylvania, on September 17 and 18.

A program closely related to the war effort is being arranged and will be announced in the near future.



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With a Nixon Gas-Lift on your well you can quickly change production from minimum allowable to its maximum volume—you can produce from high or low fluid levels; you can deplete the well without changing or adding to the original installation; you will reduce fluid-lifting costs to an extreme low.

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TEXAS — Gladewater, Barbers Hill, Bay City, Monahans, Alice, Victoria, Corpus Christi.
LOUISIANA—Lake Charles, New Iberia, Harvey, Shreveport.

Ohio Injector Company Given Army-Navy "E"

For high achievement in the production of war equipment, The Ohio Injector Company of Wadsworth, Ohio, manufacturers of O.I.C. bronze, iron, and steel valves, has received the Army-Navy Production Award consisting of the new Army-Navy "E"-for-excellence pennant, according to announcement by the Hon. James Forrestal, Under-Secretary of the Navy.

Formal presentation ceremonies were held during August at the O.I.C. Wadsworth plant, with Army and Navy officials formally making the award of the new Army-Navy "E" pennant to the company and of the Army-Navy "E" lapel insignia to all O.I.C. employees.

Word of the award was received by Wayne Young, president of the company, in an official communication from Under-Secretary Forrestal, in which he stated:

"This is to inform you that the Army and Navy are conferring upon your organization the Army-Navy Production Award for high achievement in the production of war equipment.

"This award consists of a flag to be flown above your plant, and a lapel pin, significant of major contribution to victory, for every member of your organization.

"The high and practical patriotism of the men and women of the Ohio Injector Company is inspiring and heartening. Their record will be difficult to surpass, yet the Army and Navy have every confidence that it was made only to be broken."

The Army-Navy "E"-for-excellence flag is a swallow-tailed banner, bearing a white capital "E" in a yellow wreath of oak and laurel leaves on a vertically divided blue and red background. "Army" appears in white on the red field and "Navy" appears on the blue field. The new award given jointly by the armed services supplants the present Navy "E" and the previously announced Army "A".

The Ohio Injector Company was founded in Wadsworth in 1883 by the late E. J. Young and is one of the four "Ohio Companies" that he and his associates sponsored. The other three are The Ohio Match Company, The Ohio Boxboard Company, and The Ohio Salt Company.

Kalb Made Chief Engineer Kellogg Switchboard and Supply Company

The Kellogg Switchboard and Supply Company, Chicago, Illinois, one of the nation's largest manufacturers of telephone and other communication equipment, and now busily engaged in producing war communication apparatus for the nation's armed forces, announces the appointment of Robert M. Kalb as chief engineer.

The war communication equipment being produced in the Kellogg factory is now seeing active duty on the world battle fronts. The bombing planes of General Doolittle's heroic squadron that recently bombed Tokyo carried Kellogg equipment. Walkie-Talkie radio sets, with which a soldier becomes a walking telephone booth, utilize Kellogg apparatus. Tanks, planes, radio command cars, field telephone and telegraph sets, etc., carry communication apparatus made either partially or completely in the Kellogg plant.

Kalb, a telephone research engineer of long experience was previously assistant chief engineer of the Kellogg Switchboard and Supply Company. He is a graduate of Ohio State University,

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SERVICE RECORDS *Surely help!*

Actual service records of your brake lining will enable you to *know* exactly how well and how long it functions. Then there's no guessing which lining is best for your requirements. . . . Check Grizzly service records on your own or other wells to *know* how smoothly it stops without grabbing, smoking or dusting . . . how safely it holds the load at any depth . . . how little adjusting it requires . . . and how many ton miles of service it gives before having to be replaced . . . . . Grizzly is as fine in quality and performance as brake lining can be made. It's performance is outstanding; and it is giving exceptionally long and satisfactory service wherever used, regardless of operating conditions . . . . . Be *sure*, and be *safe*. Check Grizzly records in actual service *on any well*.

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Plants: **Los Angeles, California Paulding, Ohio**
Complete Stocks Maintained in our Warehouses At:
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Department of Electrical Engineering, and took post graduate work at Columbia University. Later, he taught in the Electrical Engineering Laboratory at Ohio State University.

Kalb is well-known for his research engineering work on transmission and circuit problems, and for 13 years was associated with the Bell Telephone Laboratories. Many patents have been issued to him for improvements on various telephone apparatus.

B. A. Wallace, associated with the Kellogg Laboratory and Engineering Department for many years, has been promoted to the position of assistant chief engineer. He will be chiefly concerned with product engineering.

Marmon-Herrington Officials Surprised by Workers

Turning the tables on their bosses recently, eight members of the Marmon-Herrington Ten-Year Club marched boldly into Vice-President Bert Dingley's office, and presented the three top officials of the company ten-year service buttons.

Big, smiling Jim Lamb, one of the first Marmon-Herrington employees, led the delegation, which broke up an official conference between A. W. Herrington, president, D. I. Glossbrenner, secretary-treasurer, and Dingley. In presenting the buttons, Jim Lamb said that "turn about is fair play," and explained that a joking remark made by Dingley had prompted the men to their action. As Dingley had presented a similar button to Bob Wallace, director of engineering, the week before, he remarked that it seemed about time someone was presenting him with a button too!

The Marmon-Herrington Company organized just a little more than ten years ago by the late Walter C. Marmon and A. W. Herrington, to manufacture All-Wheel-Drive trucks, is now one of the most important producers of military vehicles in the Mid-West.

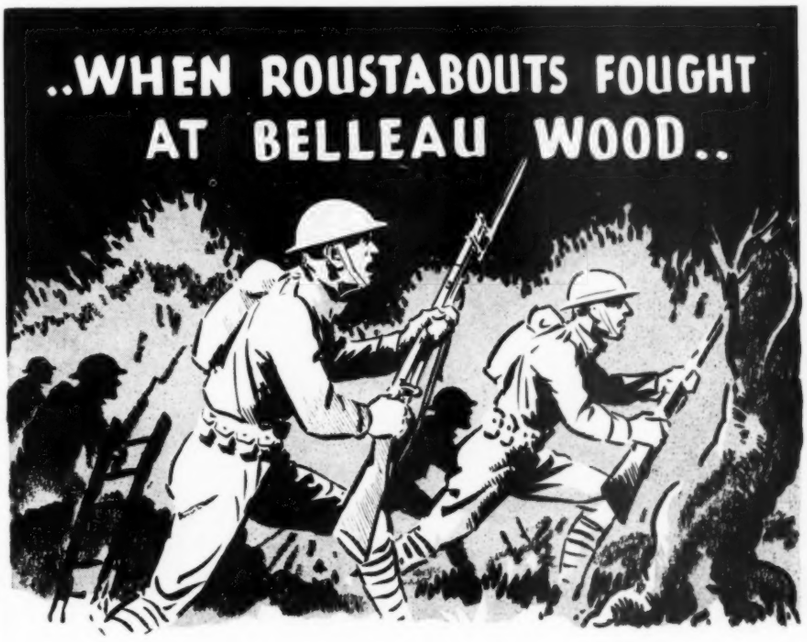
Keuffel and Esser Observe 75th Anniversary

Too busy with the rush of war orders to celebrate its 75th anniversary, the firm of Keuffel and Esser, pioneer manufacturers of draughting materials, surveying equipment, and fire control instruments for the Army and Navy, observed the occasion July 20 by presenting to each of its 2200 employees a $25 war bond and a commemorative booklet entitled "Through the Years."

Only a brief pause between working shifts was taken to commemorate the company's 75th birthday. As the whistle blew ending the day's operations, some 2000 workers at the company's Hoboken factory gathered to hear Carl M. Bernegau, senior officer of the firm, briefly review its history and commend them for an outstanding production record that has twice brought the company the award of the Navy "E."

W. L. E. Keuffel, who heads the manufacturing operations of the company, also addressed the gathering and inducted 12 new members of a company organization known as the "Old Guard," a group of 124 employees who have been with the firm for more than 25 years. Eight of these, including Bernegau and Keuffel, constitute a group known as the "Golden Guard" who have served the company more than half a century, and two employees have the unique distinction of having been with the firm continuously for more than 60 years.

To serve manufacturing industries in various sections of the country, the firm maintains distributing branches in New York, Chicago, Detroit, St. Louis, San Francisco, Los Angeles, and Montreal, Canada.



Jones Sucker Rods had Met all Pumping Conditions for 16 Years

When the "Big Parade" was on, JoneSuckeRods were serving, too. In Pennsylvania, in Ohio, at Corsicana and Spindletop . . . in every field where wells were pumping. During the years that followed, another big parade was on; the parade of a young, robust oil industry across the United States.

New fields, deeper wells, heavier loads, corrosive fluids—JoneSuckeRods were first with the improvements that solved each new pumping problem. Today, with 51 years of leadership in the Sucker Rod Industry, The S. M. Jones Company is serving in the third war of the company's history. With metal so vital to Victory, the quality of JoneSuckeRods is being appreciated now as never before.

The S. M. JONES Co.

JoneSuckeRods

General Office and Factory, Toledo, Ohio — Sales Office, McBirney Bldg., Tulsa, Okla.

C.N.G.A. Forms War Activities Committee

With a number of its members serving on various government and war committees, the formation of a War Activities Committee, consisting of these men, as a move to coördinate the aid that the natural gasoline industry can give the war effort is announced by the California Natural Gasoline Association.

The committee consists of W. W. Robinson, The Texas Company, and a member of the California Oil Industry Salvage Committee, chairman; William Moeller, Southern California Gas Company, chairman of the Natural Gas and Natural Gasoline Committee, District 5; H. L. Eggleston, Gilmore Oil Company, chairman, Temporary Sub-Committee on Natural Gasoline and Coördination of Iso-Butane, District 5; P. S. Magruder, General Petroleum Corporation, member of the Oil Industry Protection Committee, and R. D. Gibbs, chairman of the C. N. G. A. Gas Report Committee. Ex-officio member of the committee is George L. Tyler, C. N. G. A. secretary.

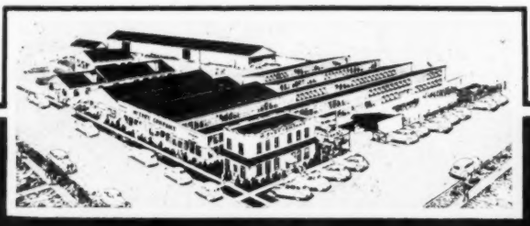
The appointment of the committee is designed to bring together those members serving on special committees outside C. N. G. A. but whose functions have a bearing on the natural gasoline industry who are working with special war-time questions and problems so that the full aid of the association and its various technical committees can most effectively be applied.

A.G.A. Meeting to Be Held in Chicago

The annual meeting of the American Gas Association will be held on Monday and Tuesday, October 5 and 6, at the LaSalle Hotel in Chicago, Illinois.

Monday will be given over to meetings of the Sections and Committees. Tuesday will be devoted to General Sessions with final adjournment in the afternoon.

The programs for these meetings, in addition to business prescribed by law and by the association's constitution, will consist of discussions of war and postwar problems only. In order that the programs may be strictly up-to-date, it is probable they will not be completed until shortly before the meeting.



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Simple in design, ruggedly built for heavy duty service. Gear ratio and throw of crank produce required speed with no strain. Heads and cranks of 100 CC and 15 CC machines are interchangeable. Meets A.S.T.M. Standard Method D-96 and A. P. I. Code No. 25 requirements.

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A.P.I. Central Oklahoma Chapter Reorganized

The Central Oklahoma chapter of the American Petroleum Institute's Division of Production has been formed in a reorganization of the former Oklahoma City chapter, which has been inactive for more than three years. About 25 attended the meeting at which Herbert Goodpaster, chairman of the Mid-Continent district, presided, and C. A. Young, secretary of the Institute's Division of Production, acted as secretary.

Chapter officers elected were Don A. Miller, Phillips Petroleum Company, chairman; H. O. Harder, Cities Service Oil Company, Wesley Moore, British American Oil Producing Company, and Ed Stewart, The Ohio Oil Company, vice-chairmen, and R. F. Schooling, British American Oil Producing Company, secretary-treasurer. Stewart is from Edmond, Oklahoma; all others are from Oklahoma City.

District Managers Appointed by Kobe

C. E. BUCHNER, JR.

Kobe, Incorporated, has announced the advancement of two of their district personnel, C. E. Buchner, Jr., having been advanced from district representative at Houston to district manager in charge of the company's newly created Gulf Coast District, and W. C. Gilmore having been promoted from the managership of the Panhandle District to that of the East Texas District. Both moves were in accord with the further development of the sales and operational activities of the company.

W. C. GILMORE

Gilmore, after completing his studies at the Cameron Junior College at Lawton, Oklahoma, in 1934, joined the Lone Star Gas Company, and later, the Slick-Urschel Oil Company where he was in charge of that company's pumping operations in the Oklahoma City field. He joined Kobe, Incorporated, in 1937 and since that time has had a thorough experience with hydraulic pumping in practically all fields in Oklahoma, the Texas Panhandle, and North Texas.

After graduating from the School of Engineering at Tulsa University, Buchner was for a number of years concerned with pumping problems in Oklahoma, Kansas, and the Gulf Coast. He joined Kobe, Incorporated, in 1941 as district representative at Houston, which position he has held until his recent promotion to the managership of the Gulf Coast District.

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E-210	C-68	B-51	A-35
E-240	C-75	B-55	A-38
E-270	C-81	B-60	A-42
E-300	C-85	B-68	A-46
E-330	C-90	B-75	A-51
E-360	C-96	B-81	A-60
D WIDTH	C-105	B-85	A-68
D-120	C-112	B-90	A-75
D-128	C-120	B-97	A-80
D-144	C-128	B-105	A-85
D-158	C-144	B-112	A-90
D-162	C-158	B-120	A-96
D-173	C-162	B-128	A-105
D-180	C-173	B-144	A-112
D-195	C-180	B-158	A-120
D-210	C-195	B-173	A-128
D-240	C-210	B-180	
D-270	C-240	B-195	
D-300	C-270	B-210	
D-330	C-300	B-240	
D-360	C-330	B-270	
	C-360	B-300	

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IMMEDIATE SHIPMENTS

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"BUY MORE WAR BONDS"

Special School Prepares Piping Draftsmen

One of the principal bottlenecks that occurred during the aircraft industry's vast expansion program was caused by the scarcity of trained aeronautical draftsmen. To relieve that situation, the aviation industry, with government cooperation, initiated a plan whereby vocational schools were established at the various airplane plants for the conversion of engineers, both men and women, from other fields into aeronautical draftsmen. So successful was this plan in the results obtained and in operation that it has been adopted by the petroleum industry in the field of refinery and natural gasoline plant engineering and design as a means of bringing quick relief to a serious bottleneck that threatens to develop through the scarcity of piping draftsmen, retarding petroleum plant construction.

The first of these schools was recently established by The Fluor Corporation, Ltd., where the drafting department has undergone a growth from 60 draftsmen, before the war, to a point where the company now employs 225 and has provided facilities for a total of 300 draftsmen. Students from the classes will supplement that number upon completion of the course.

Instructor of the class is Walter Lipman, formerly employed as a piping draftsman by Union Oil Company of California and General Petroleum Corporation and currently employed as a vocational teacher with the Los Angeles County Board of Education in the Montebello, California, School District. Lipman is paid by the Montebello School District, which is reimbursed for his salary by the Federal Government as part of its Defense Educational System. The Fluor Corporation, Ltd., in turn, employs and pays each student a wage during his period of instruction.

Students entering the class must meet certain definite requirements as to general education and experience, the minimum being graduation from high school and at least two years' experience in mechanical drafting or a university education with at least two years' experience in engineering. Thus, architectural draftsmen, mechanical draftsmen, and engineers with mechanical drawing experience from all fields are eligible under the plan.

The course of study is planned to capitalize each student's previous experience and it is built around the fundamentals of refinery and natural gasoline plant piping drafting.

View of Fluor piping drafting classroom

To accommodate the students and to provide the necessary facilities, The Fluor Corporation, Ltd., built a special classroom building. Classes are limited to a total of 24 students so that thorough personal instruction and supervision of each student is possible, but no definite time is set for the progression of the student from classroom work to The Fluor Corporation's drafting department. Completion of the course is governed by each student's natural demonstration of his ability to absorb learning in the subjects taught.

One of the features of the plan is the inclusion of women in the classes. They are required to meet the same qualifications as men as to education and previous experience. Initial experience quickly established the fact that women meeting the essential qualifications are available, adaptable and temperamentally well-suited for the work.

Cummins Regional Office Enlarged

Better to serve the increasing number of Cummins Diesel users in the oil fields, the Cummins Engine Company has enlarged their regional offices at Fort Worth, Texas.

Formerly in the Mid-Continent Building, the company has taken larger quarters at 1812 Fair Building, where J. B. Chambers, regional manager, will be in position to facilitate the handling of all sales and service matters through the distributors, the Mid-Continent Supply Company and the Cummins Diesel Sales and Service Company, Inc.

Chambers is well known in the Mid-Continent area, having been appointed regional manager at Fort Worth in 1935. Affiliated with the Cummins Engine Company since 1925, Chambers obtained his Diesel training in various capacities at the Cummins factory. Beginning as apprentice machinist, he operated drill press, lathe, milling machine, screw machine, and key cutter. Transferred to service maintenance in 1928, he acted as test block foreman, and was later sent to the East Coast where he supervised the installation of marine engines and auxiliary generating sets in various types of boats. He returned to the factory in 1930 as experimental engineer—running laboratory tests, and building experimental trucks, buses, and race cars.

J. B. CHAMBERS

In 1935 Chambers was chosen as Cummins representative in the important petroleum territory, where he is responsible for all Cummins activities.

Correction

An error appears in Table 1 of the article by H. J. Struth, beginning on page 23 of the Annual Number (July 1). Wells drilling July 30, 1942, should have read 2312 instead of 1879. The figure 1879 is the difference between wells drilling June 30, 1941, and June 30, 1942. The percentage decrease, 55 percent, shown in the last column of the table, is correct.

VORTOX AIR CLEANERS can go a long way toward helping you through the tight spots on today's engine maintenance needs. These Cleaners provide protection for your engine right where protection is needed most—on cylinder walls, pistons, valves, and other vital parts—by *keeping dust and grit out!*

A Vortox Cleaner thoroughly scrubs the incoming air before it reaches the engine manifold. Whirling action of the air first throws out larger dust particles . . . cyclonic oil spray and the oil washed filter then give a *second* and a *third* cleaning that lets nothing but *dust-free* air into the combustion chamber.

NO FILTER WEAR — All dirt is trapped in an oil filled sump and does not again contact the incoming air. *(Only maintenance required is an occasional change of oil.)* The all-metal filter is kept constantly clean by the washing action of the oil spray . . . that's why Vortox Cleaners maintain peak efficiency—on all types of engines and under all kinds of dust conditions!

For long, low-cost engine operation — specify Vortox!

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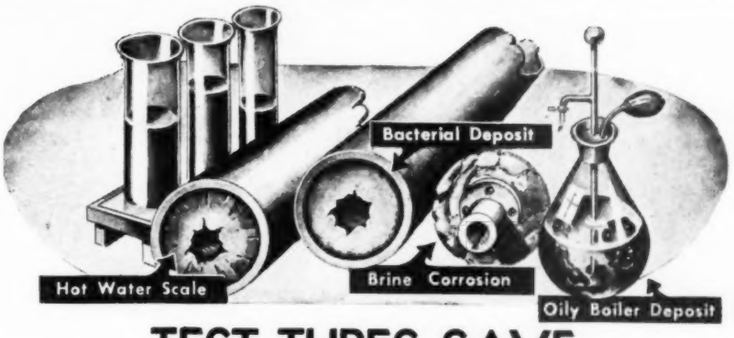

TEST TUBES SAVE WATER TUBES

Haering products and Haering service are directly stepping up war production. They control corrosion in boilers, condensers and engine cooling systems and all water equipment used in gasoline production, munitions, tanks and many other war products.

Our ability to read water and our many glucosate correctives are doing active service in war industries.

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STUB END WRENCHES

These extra heavy, ruggedly designed Chrome Vanadium Steel Wrenches take long tubular slip-over handles, stand up to long leverage... tighten screws, bolts and nuts far tighter or loosen them even when badly corroded. These are ideal wrenches around rigs, pipe lines and for general heavy duty work. Three types (from 1¼" to 3½") with long, slip-over tubular steel handles, each of which fits several sizes.

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Here's What's New IN First Aid Kits

Shortages of essential materials started us looking for new First Aid Kit materials... and led us into one of the most practical lines we have ever produced; dustproof and moisture proof in natural finish wood ...as handsome as any we've turned out in our many years of supplying safety to industry.

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Send us your new free folder describing the new line of Bullard First Aid Kits that use less critical material and helps keep skilled men on the job.

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NATIONWIDE SALES AND STOCKS

A.P.I. Meeting to Be at Palmer House Nov. 9-13

The American Petroleum Institute's Twenty-third Annual Meeting will be held at Chicago on the dates originally scheduled, November 9 to 13, but at the Palmer House instead of the Stevens Hotel, President William R. Boyd, Jr., announces.

The Stevens Hotel recently was requisitioned by the government for the Army Air Corps.

"This will be strictly a War Convention," Boyd said. "The Institute's annual meetings always have been working meetings, entirely different from the usual concept of an American businessman's convention, and now the far-reaching problems of the war make it more important than ever to assemble the oil industry's workers periodically for an analysis of common difficulties."

Plans for the meeting have not yet been completed, but it is expected that a preliminary program will be distributed some time early in the fall, Lacey Walker, secretary-assistant treasurer, reports. Only those committees that are working on problems contributing in some measure to the industry's war effort will convene during the meeting, and technical group sessions will hear and discuss papers on the war-time progress in the various branches of the industry. There will be no annual dinner.

"Reports of progress in the solution of the technological problems of drilling and production, of transportation, and of refining, always have been the major reason for Institute meetings, and within the limits of war secrecy these reports become preeminently important now," Boyd said.

"The industry's technological problems are magnified a hundredfold by war—by lack of necessary materials, by disruptions of transportation, by demands for war products, and by shattering blows at the normal conduct of an integrated business such as ours, where the slightest alteration in supply and demand in one part of the country has its inevitable reaction in other parts of the country.

"Even more important than the discussion of these problems, perhaps, is the opportunity that wartime meetings afford to learn just what the government has been doing, and what it intends to do, that affects the oil business. We expect that the Petroleum Coördinator, the Deputy Coördinator, and divisional heads of that organization and authorities in other war agencies having to do with petroleum operations will attend and discuss in general sessions the problems in which every oil man is so vitally interested."

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A distinctive hotel—located in the heart of New York's finest shopping district—near the best theatres and gayest night clubs. In the hub of the City's social and cultural district, it offers an unusually central place to stay while in town. Here, spacious rooms, superb service, a quiet and refined atmosphere, and excellent cuisine, make for dignified living.

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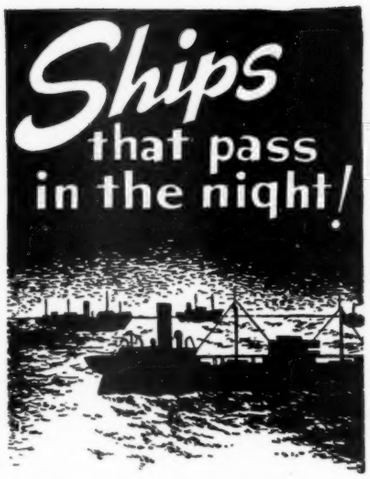

We are all in accord that this will be a long, hard war....The bottleneck of war production has definitely been broken and weapons are beginning to pile up. Since we are now over the hump, another grave problem has developed ... that of getting these weapons where they are needed most ... on the firing line. Simply, this means more and faster ships.... Losses of "Ships That Pass in the Night" are mounting daily. Let's give 'em more ships so they can give the Axis more Hell in the good old American way. Let's buy more Bonds and Stamps. ... Let's start more 10% Clubs.... Let's go all out for the Knockout.

★

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Hotel Faust.....Rockford
LOUISIANA
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NEBRASKA
Hotel Paxton.....Omaha
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Hotel Clovis.....Clovis
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Hotel Wade Hampton.....Columbia
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Coronado Courts.....Galveston
Jack Tar Court.....Galveston
Miramar Court.....Galveston
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Affiliated NATIONAL HOTELS
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SERVING 10 STATES AND OUR NATION'S CAPITAL

Cameron Receives Navy "E" with White Star

Cameron Iron Works, Inc., Houston, Texas, has been awarded the coveted All-Navy "E" Burgee with White Star signifying continued outstanding production of Naval Ordnance. Formal presentation of the award was made July 19 by Rear Admiral P. W. Foote at a ceremony that also celebrated the dedication of Cameron's new Houston plant.

Firm Name Changed

The name of the E. A. Hill Company, Inc., subsidiary of Jas. P. Marsh Corporation, Chicago, has been changed to Dependable Manufacturing Company (Division of Jas. P. Marsh Corporation).

General offices of Dependable Manufacturing Company are at 2073 Southport Avenue with factory operations at 430 West Erie Street.

The Dependable Manufacturing Company is engaged exclusively in the production of tools used in the manufacture of armaments.

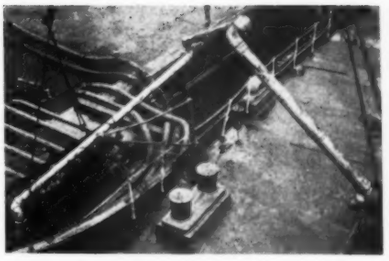
Gary Resigns as OPC Director of Refining

Wright W. Gary, OPC director of refining, resigned effective August 1 to accept a position as president of Filtrol

(Universal Press Photo Service)
WRIGHT W. GARY

Corporation, Los Angeles, California. P. M. Robinson, assistant to Gary, has been appointed acting director of refining.

Before taking the post with OPC last year, Gary was assistant to the vice-president of the M. W. Kellogg Company.



"DOWN TO THE SEA IN SHIPS"

Oil and gasoline rank high among the commodities which must be delivered to our forces throughout the world. Loading and unloading facilities must be safe and dependable. *Take no chances* with weakened or worn-out flexible loading lines.

PLAY SAFE!

CHIKSAN All-Steel Loading and Unloading Hose combines the strength and long life of steel with all necessary flexibility. It can be used for loading or unloading—pressure or suction —or for underwater service. Nothing to tighten or adjust. Light in weight. Folds into a compact unit when not in use.

FLEXIBLE DOCK RISERS

STYLE 30
Chiksan Swing Joint with flanged ends.

CHIKSAN Ball-Bearing Swing Joints are widely used as Dock Risers.... These flexible end connections eliminate strains on fabric hose and permit the use of shorter lengths. When fabric hose is worn out, the Chiksan Swing Joints can be used to assemble your own flexible steel hose.

CHIKSAN Ball-Bearing Swing Joints are supplied with threaded or flanged ends or borsed for welding. Made in sizes from ⅜ in. to 12 in. Special sizes to order. Over 500 different Types, Styles and Sizes for every purpose.

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BALL BEARING SWING JOINTS for ALL PURPOSES
BREA, CALIFORNIA
ALL-STEEL ROTARY HOSE
CIRCULATING HEADS · MUD GUNS

TRADE LITERATURE

What to Write For

A FOUR-PAGE PAMPHLET has just been released by the E. D. Bullard Company, 275 Eighth Street, San Francisco, California. The benefits of certain hot weather needs for workers, including salt tablets, cellulose sponge sweat pads, Venex snake bite treatment, and poison oak and ivy treatments are included. Copies of the folder entitled "Hot Weather Needs That Aid Working Efficiency," are available on request.

INSTRUMENTS for the automatic measurement and recording of densities of process liquids are described and illustrated in Bulletin A-264 just released by The Foxboro Company, Foxboro, Massachusetts. Copies will be sent on request. The Foxboro Density Recorder and Stabilog Density Controller are fully described.

A COMPREHENSIVE 4-page bulletin, illustrated in color, describing Reed rotary drilling tools, rock bits, tool joints, and core drills, will be sent on request without obligation.

A NEW operating practice manual just published by Johns-Manville, 22 East 40th Street, New York, is designed to help obtain maximum production from equipment and eliminate unnecessary shut-downs. Called "101 Suggestions for Good Operating Practice," the guide outlines in tablular form many hints on lengthening the life of packings, insulations, roofings, friction materials, and refractory products. Copies of the book, Form PP-9A, will be sent on request.

A NEW BULLETIN giving up-to-date information on National and Karbate carbon and graphite corrosion-resistant pipe, tubes, and fittings, has been released by the National Carbon Company, Inc., P. O. Box 6087, Cleveland, Ohio. Copies of this valuable new bulletin will be sent without obligation.

CASE HISTORY DATA on condensate corrosion control by the Haering process of direct introduction of chemicals into the steam has been released for the first time in a new Haering six-page pamphlet entitled "Cook County School of Nursing Solves Condensate Corrosion Problem." The publication tells the story of a condensate corrosion problem condition encountered in the new 17-story Cook County Nurses Home where double extra heavy wrought iron piping failed in 30 days' service. This condition provides the background for interesting data on the application of Tetra Phospho Glucosate to steam conditioning. Copies of the pamphlet are available on request from D. W. Haering and Company, Inc., 205 West Wacker Drive, Chicago, Illinois.

THE AIR-ACTUATED REMOTE RECORDER AND CONTROLLER, a sensitive device for the recording and control of pressures, rates of flow, and liquid levels over any distance is described in Bulletin E-22, obtainable on request from American Meter Company, Erie, Pennsylvania.

NEW DESCRIPTIVE BULLETINS U5-142 (TC-23 Unit) and U6-442 (TC-33H Unit); also other up-to-date bulletins

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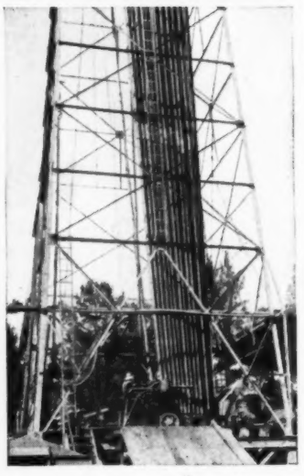

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THE FRANCE PACKING COMPANY, Tacony, Philadelphia, Pennsylvania, offers its Catalog No. M-3 on request without obligation describing "full floating" metal packing.

A BOOKLET explaining the Ozalid Process of making dry-developed, positive-type whiteprints has been released by Ozalid Products Division of General Aniline and Film Corporation, Johnson City, New York. The booklet is available on request.

BULLETIN W-111-B31, a current release by Worthington Pump and Machinery Corporation, Harrison, New Jersey, contains a full description of the company's horizontal single piston pumps, type AC, with valve plate type-pressures to 250 lb. per sq. in. A copy of the bulletin will be sent on request.

THE MODEL 12 Buckeye wheel-type trencher has a number of special features that are fully described in the new two-color, illustrated bulletin sized for convenience in filing and for reference. This bulletin, which covers all improvements and refinements on the Model 12, will be sent on request to the Buckeye Traction Ditcher Company, Findlay, Ohio.

EASTMAN OIL WELL SURVEYS, Dallas, Texas, and Long Beach, California, are releasing catalog No. 41, presenting important information concerning applications of controlled directional drilling and oil-well surveys, including deflecting tools, orienting services, survey instruments, multiple-shot survey service, bits, reamers, milling tools, and casing roller service. Covering instructions for operation of instruments and tools, together with detailed specifications, the catalog is available for the asking.

A NEW 14-PAGE "FIGHT WASTE" BULLETIN—"Make 3 do the work of 4"—has been issued by Air Reduction Sales Company, 60 East 42nd Street, New York, New York. The booklet, which consists of a series of shop posters, is designed to help arc-welding operators do more useful work with every electrode. Copies of this helpful booklet may be had without obligation.

J. E. Muirhead Promoted by International-Stacey

International-Stacey Corporation announces the appointment of John E. Muirhead as assistant to the president, with headquarters at Columbus, Ohio.

Muirhead has had an extensive career in manufacturing and industrial engineering. Prior to his association with International-Stacey he was affiliated with the National Automatic Dispensers, Inc., Montclair, New Jersey, in the capacity of vice-president, and with the Scovill Manufacturing Company, Waterbury, Connecticut, in various capacities in the manufacturing department. For ten years he was with Sanderson and Porter, engineers, in New York and Chicago, as a member of the industrial engineering staff.

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Book Reviews

Transactions A. I. M. E. (1942) Volume 146, Petroleum Development and Technology, published by the American Institute of Mining and Metallurgical Engineers, 29 West 39th St., New York, New York. Bound in cloth, 565 pp.; price, $5.00.

This volume is the seventeenth of the *Petroleum Development and Technology* series of the Petroleum Division of A.I.M.E. and contains papers and discussions presented before the division at meetings held at New York, New York, February 17-20, 1941, and February 9-12, 1942; Dallas, Texas, October 16-18, 1941; Los Angeles, California, October 29-30, 1941, and also the petroleum statistical reports covering the year 1941.

There are five chapters in the volume devoted exclusively to production engineering, enginering research, petroleum economics, production, and refining.

Chairman of the Petroleum Division, Harry P. Stoltz, has recommended this volume of the *Transactions* to members of the institute. A very critical selection of the many excellent papers presented before the various meetings was made due to space and funds.

•

Water Handbook, published by W. H. and L. D. Betz, Gillingham and Worth Streets, Frankford, Philadelphia, Pennsylvania. 64 pp., spiral bound, 8½ in. by 11 in. Price, 50 cents postpaid.

A complete handbook on industrial and muncipal water, which is arranged in two sections, "Water Analyses" and "Interpretations."

In the first section, 25 different methods of water analyses are discussed at length, with procedures and calculations. Such water analyses as hardness, alkalinity, phosphate, sulfite, turbidity, oil, calcium, specific conductance, etc., are covered. With but one exception, all tests are simple, accurate determinations requiring little or no previous chemical background. Bacteriological analyses are not included.

The second section of the book is devoted to interpretations of the tests and their application to plant control. Included here are discussions of such subjects as carbonate and noncarbonate hardness pH control, steam purity, inter-crystalline cracking, corrosion, and many others.

Scattered throughout the *Water Handbook* are 16 useful technical graphs and 15 illustrations of different pieces of testing equipment.

•

Oil and Petroleum Year Book 1942. Published by Walter E. Skinner, 20 Copthall Avenue, London, E. C. 2. Price, 10s. net; 11s. post free abroad.

The 1942 edition, the 33rd year of issue of this standard reference work, compiled by Walter E. Skinner, has just been published. Complete and up-to-date particulars are given concerning 514 companies covering all branches of the oil industry. American and foreign companies are fully dealt with.

The particulars of each company comprise names of directors and other officials, seat of operations, description of business, details of capital, dividends, and financial results.

The many changes that have taken place since the last issue are recorded in its pages, and with the present difficulty of obtaining reliable information concerning some oil companies in war areas, the book is of value to all interested in this important industry. Other useful features are the names and addresses of 208 managers and engineers and the names of the companies with which they are connected, and a directory of manufacturers of oilfield and refinery equipment, comprising 282 headings.

MEETINGS

California Natural Gasoline Association, Monthly Meeting—September 3, Barker Bros. Auditorium, 818 West Seventh Street, Los Angeles, California.

National Petroleum Association, Annual Meeting—September 17 and 18, William Penn Hotel, Pittsburgh, Pennsylvania.

American Institute of Mining and Metallurgical Engineers, Regional Meeting—October 2, St. Louis, Missouri.

American Gas Association, Annual Meeting—October 5 and 6, LaSalle Hotel, Chicago, Illinois.

Texas Mid-Continent Oil and Gas Association—October 8, 9, and 10, Dallas, Texas.

Western Petroleum Refiners Association, Regional Meeting—October 9, Allis Hotel, Wichita, Kansas.

American Society of Mechanical Engineers, Fall Meeting—October 12, 13, and 14, Rochester, New York.

American Institute of Mining and Metallurgical Engineers, Petroleum Division—October 12, 13, 14, 15, 16, and 17, Los Angeles, California.

Indiana Independent Petroleum Association—October 14 and 15, Hotel Severin, Indianapolis, Indiana.

National Stripper Well Association, Annual Meeting—October 19, Wichita, Kansas.

Independent Petroleum Association of America, 13th Annual Meeting—October 19, 20, 21, and 22, Wichita, Kansas.

National Lubricating Grease Institute, Annual Meeting—October 25, 26, 27, 28, and 29, New Orleans, Louisiana.

National Safety Congress and Exposition—October 27, 28, and 29, Sherman Hotel and Palmer House, Chicago, Illinois.

American Institute of Mining and Metallurgical Engineers, Petroleum Division—October 29, 30, and 31, Austin, Texas.

Western Petroleum Refiners Association, Regional Meeting—October 30, Washington-Youree Hotel, Shreveport, Louisiana.

Illinois Mineral Industries Conference—October 30 and 31, Urbana, Illinois.

American Association of Petroleum Geologists—November 5 and 6, Los Angeles, California.

California Natural Gasoline Association—November 5 and 6, Los Angeles, California.

American Petroleum Institute, Annual Meeting—November 9, 10, 11, 12, and 13, Palmer House, Chicago, Illinois.

American Institute of Chemical Engineers, 35th Annual Meeting—November 16, 17, and 18, Netherland Plaza, Cincinnati, Ohio.

American Chemical Society, National Chemical Exposition—November 24, 25, 26, 27, 28, and 29, Sherman Hotel, Chicago, Illinois.

American Society of Mechanical Engineers, Annual Meeting—November 30 and December 1, 2, 3, and 4, New York, New York.

American Institute of Mining and Metallurgical Engineers, Annual Meeting—February 15, 16, 17, and 18, 1943, New York City.

American Petroleum Institute, Division of Production, Eastern District—April 8 and 9, 1943, William Penn Hotel, Pittsburgh, Pennsylvania.

Death Calls Joe Moorhead

Joe Moorhead, manager of the Pennsylvania Grade Crude Oil Association, died in the Emergency Hospital, Washington, D. C., August 9, after a very brief illness. He was taken ill suddenly on Friday evening and was removed to Emergency Hospital, passing away on Sunday.

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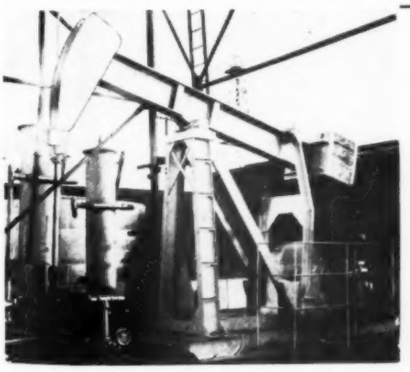

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Index to Advertisers

Acme Fishing Tool Co.
Affiliated National Hotels 143
Air Reduction Co., Inc.
Allis, Louis, Co. 65-66
American Air Filter Co., Inc. 110
American Cable Division of American Chain and Cable Company, Inc. Inside Back Cover
American Chain & Cable Company, Inc. Inside Back Cover, 85
American Hammered Piston Ring Division 99
American Iron & Machine Works
American Meter Company 5
American Roller Bearing Co.
American Sand-Banum Co., Inc. 138
Armstrong Bros. Tool Co. 142
Axelson Mfg. Co.
B and W, Inc.
Baash-Ross Tool Co. 47
Baker Oil Tools, Inc. 121
Baldwin De LaVergne Sales Corp.
Bantam Bearings Corp. 116
Baroid Sales Co. 9
Bartlett-Hayward Division 99
Bethlehem Steel Co.
Brown Instrument Co.
Bucyrus-Erie Co. 53
Bullard, E. D., Co. 142
Cameron Iron Works 43
Cardwell Mfg. Co. 1
Carlyle Rubber Co. 140
Chapman Valve Mfg. Co., The 112
Chiksan Tool Co. 143
Clark Bros. Co.
Cleveland Trencher Co. 129
Climax Molybdenum Co.
Continental Motors Corp.
Continental Supply Co., The 41
C. Lee Cook Mfg. Co. 15
Cooper-Bessemer Corp. 34-35
Cooper, Fred E.
Crane Co. 8
Cummins Engine Co. 100
Curtin, W. H., & Co. 138
Dearborn Chemical Co. 114
Dowell, Inc. 17
Durametallic Corp
Edwards Valve & Mfg. Co.
Elastic Stop Nut Corp.
Electro Metallurgical Co.
Emsco Derrick & Equipment Co. 81
First National Bank in Dallas 131
Fisher Governor Co.
Fluid Packed Pump Co. 74
Fluor Corp., Ltd.
Foster Wheeler Corp. 39
Foxboro Co.
France Packing Co. 124
Frick-Reid Supply Corp.
Gaso Pump & Burner Mfg. Co. 61
General Paint Corp. 130
Gotham Hotel 142
Graver Tank & Mfg. Co., Inc. 106
Grizzly Mfg. Co. 136
Guiberson Corp. 126-127
Gulf States Utilities Co.
Haering, D. W., & Co., Inc. 141
Halliburton Oil Well Cementing Company Back Cover
Happy Company 78
Haynes Stellite Company
Hazard Wire Rope Division of American Chain and Cable Co., Inc. 85
Hill, Hubbell & Co., Division 130
Hudson Engineering Corp.
Hughes Tool Co. 49
Hunt Tool Co. 11
Hyatt Bearing Division, General Motors Sales Corp. 104
Jarecki Mfg. Co.
Jensen Bros. Mfg. Co. 147
Johns-Manville
Jones & Laughlin Steel Corp.
Jones, S. M., Co. 137
Kerotest Mfg. Co.
Keuffel & Esser Co.
Kobe, Inc.
Koppers Company 99
American Hammered Piston Ring Division, Bartlett Hayward Division, Engineering and Construction Division, Wood Preserving Corp., The
Lane-Wells Company 97
LeRoi Company 108
Leschen, A., & Sons Rope Co.
Lincoln Electric Company 51
Linde Air Products Co.
Link-Belt Co. 83
Lone Star Cement Corp.
Lufkin Foundry & Machine Co. 19
Lufkin Rule Co. 128
Lunkenheimer Co., The
McCullough Tool Co.
McEvoy Company 138
Macwhyte Company 3
Marley Company 21
Marmon-Herrington Co.
Marsh, Jas. P., Corp. 145
Martin-Decker Corp. 148
Merco Nordstrom Valve Co. Front Cover
Mid-Continent Pump & Supply Co. 132
Midwest Piping & Supply Co., Inc. 68
Mission Mfg. Co.
National Carbon Company, Inc., Carbon Sales Division 93
National Supply Co., The 70
National Tube Company
Oakite Products, Inc. 146
Ohio Injector Company
Oil Well Supply Co. 89
Otis Pressure Control, Inc. 125
Pacific Pump Works
Patterson-Ballagh Corporation
Penberthy Injector Co. 13
Petroleum Electric Power Association 58
Petroleum Rectifying Co. 95
Pittsburgh Equitable Meter Co.
Pomona Pump Co.
Reading-Pratt & Cady Division of American Chain & Cable Co., Inc.
Reed Roller Bit Co. 22
Reilly Tar & Chemical Corp.
Republic Steel Corp. Inside Front Cover
Ridge Tool Co. 2
Rockford Drilling Machine Division 144
Roebling's, John A., Sons Co. 55
Schlumberger Well Surveying Corp.
Smith, A. O., Corp.
Southern Mill & Mfg. Co.
Southwestern Gas & Electric Co.
Spank Chalfant, Inc. 119
Spang & Company 123
Sperry-Sun Well Surveying Co.
Staynew Filter Corp.
Tank Seal Products Company
Taylor Forge & Pipe Works 57
Texaco Development Corp.
Texas State Hotel 146
Texasteel Mfg. Co. 45
Toledo Pipe Threading Machine Co. 147
Tretolite Co. 87
Tube-Turns, Inc. 37
Union Carbide and Carbon Corp.
Union Wire Rope Corp. 139
U. S. Steel Corp. Subsidiaries 89
U. S. Treasury Dept. 60
Universal Atlas Cement Corp. 6
Vogt, Henry, Machine Co., Inc. 63
Vortox Manufacturing Company 141
Wagner Electric Corp.
Wall-Colmonoy Corp. 134
Waukesha Motor Company
Whitney Chain & Mfg. Co., The
Williams, J. H., & Co.
Wilson Supply Co. 135
Wisconsin Motor Corp.
Worthington Pump & Machine Corp.
Wyatt Metal & Boiler Works 91
Young Radiator Co.
Youngstown Sheet & Tube Co. 7